VOLUME XXXVII NO. 194 SEPTEMBER-OCTOBER 1952

LAND SEA AIR ORDNANCE

Reg. U. S. Pat. Off.

ADM. W. M. FECHTELER
Chief of
Naval Operations,
United States Navy

IN THIS ISSUE

★ The Atomic Bomb . . . . . Maj. Gen. J. F. C. Fuller
★ Firepower in Korea . . . . . Mark S. Watson
★ Ordnance Ammunition Center . Brig. Gen. J. S. Holmes
★ The Aircraft Gun Problem . . . Col. René R. Studler

STRONG HANDS

are needed to shape America's future.

Take an active interest in politics today. It's our best protection against Socialistic regimentation tomorrow.

Know how your candidates stand.

BOHN ALUMINUM & BRASS CORPORATION

GENERAL OFFICES: LAFAYETTE BLDG. • DETROIT 26, MICHIGAN

CASTINGS • FORGINGS • PISTONS • BEARINGS • EXTRUSIONS
INGOTS • REFRIGERATION PRODUCTS • AIRCRAFT PARTS
AUTOMOTIVE REPLACEMENT PARTS

TELEVISION!

"American Forum of the Air" . . . . . Every Sunday on NBC Television
Consult Your Newspaper for Time and Station

BOHN

Founded 1920

ORDNANCE

☆ LAND
☆ SEA
☆ AIR

The Magazine of Scientific and Industrial Preparedness

Vol. XXXVII SEPTEMBER-OCTOBER, 1952 No. 194

FEATURES

Adm. William M. Fechteler . . . . . Front cover
Exclusive photograph for ORDNANCE *by Harris & Ewing*

"Keep Your Powder Dry" . . . . . Frontispiece

The Navy Is Ready 241
Our sea forces are in a high state of preparedness

A New Look at the Atomic Bomb . . **Maj. Gen. J. F. C. Fuller** 242
A valuation of the limitations and power of the nuclear weapon

The Brick House at Sandy Hook 247
It nurtured old traditions and fine Ordnance officers

Milestone of Production 250
Allison completes the 10,000th cross-drive tank transmission

Ammunition Expenditure in Korea . . . . **Mark S. Watson** 251
The cost of "trading metal for flesh" in the Far East

Industry-Ordnance Teamwork 255
Chrysler Delaware Tank Plant produces the Patton 48 tank

The Aircraft Gun Problem . . . . . **Col. René R. Studler** 256
Should the rifle or shotgun principle of fire prevail?

The War in Korea . . . . . **Jerry Greene** 261
The enemy is well supplied with good combat equipment

The Ordnance Ammunition Center . **Brig. Gen. Joel S. Holmes** 264
Directing agency of the new integrated production program

Fifty Years of American Arms Development . . **John J. O'Connor** 270
Unique record of the United States Ordnance Company

Month by Month 272
Highlights of the national defense

Preparedness—for the Long Pull 275
An editorial about our responsibility for a sustained defense

DEPARTMENTS

Atomic Energy . . . . 234 **Ordnance in Review** . . . 306
Association Affairs . . . 276 **Book Reviews** 312
New Developments . . . 282 **Ordnance Book Service** . . 323
From the Record . . . . 300 **Index of Advertisements** . . 337

ARMAMENT TECHNOLOGY

The Projectile in Flight . . . . . **Col. H. U. Wagner** 339
Effects of eccentric wall thickness on shell behavior

Helicopter Maintenance . . . . . **Col. William B. Bunker** 346
We need a system of support for a growing helicopter program

Building Dependable Ordnance . . . . . **Vernon M. Korty** 350
A complex device is only as good as the sum of its parts

ORDNANCE is published bimonthly by the American Ordnance Association, 705 Mills Building, Washington 6, D. C. Entered as second-class matter, August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second-class entry at the Post Office at Richmond, Va. Subscription rate: Continental U. S. and possessions, $4.50 annually, in advance; foreign, $6.00. Copyright 1952 by the American Ordnance Association. Title registered United States Patent Office. Six weeks' notice before next publication date required for change of address. ORDNANCE is combined with FIREPOWER and LOGISTICS, formerly published by the American Ordnance Association. *Editor:* Leo A. Codd. *Managing Editor:* R. E. Lewis. *Editorial Staff:* M. L. Van Horn, J. J. O'Connor, F. W. Foster Gleason, R. K. Smith. *Staff Assistants:* C. C. Alexander, G. C. Anderson, P. Cooke, G. M. Crump, L. F. Del Grosso, F. G. Ferriter, M. E. Ferriter, K. C. Hankey, R. La Rue, B. M. Rounds, M. J. Webb, N. A. Woodhouse. *Advertising representative:* Thomas O. Woolf & Son, 70 E. Forty-fifth Street, New York 17, N. Y. Advertising rates and publication schedule sent on request.

"Grasp at the shadow... lose the substance"

A DOG had stolen a piece of meat out of a butcher's shop, and was crossing a river on his way home, when he saw his own shadow reflected in the stream below. Thinking that it was another dog with another piece of meat, he resolved to make himself master of that also; but in snapping at the supposed treasure, he dropped the bit he was carrying, and so lost all.

Those who grasp at the shadow are likely to lose the substance.

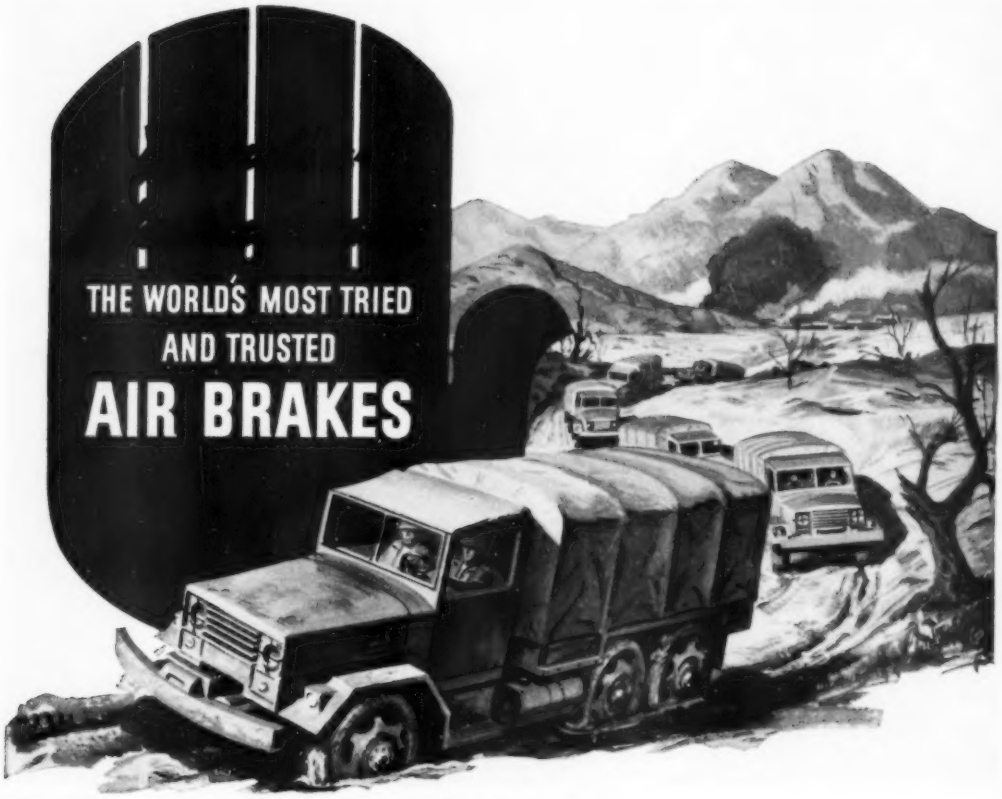
— *Aesop's fable,*
"The Dog and the Shadow"

DUTY HONOR COUNTRY
LABOR BUSINESS GOVERNMENT

W. B. Stevens President

The Gray Manufacturing Company, Hartford, Connecticut
makers of the Audograph Electronic Soundwriter

AND GRAY RESEARCH AND DEVELOPMENT CO., INC., SPECIALISTS IN VIDEO, AUDIO, SUBAUDIO ELECTRONIC MECHANISMS



Built to Outlast and Outperform any other Braking System

Like Ordnance vehicles themselves, Bendix-Westinghouse Air Brakes are built for sturdy, dependable service no matter how tough the braking chore. The Bendix-Westinghouse compressor, for example, is designed and built on the same **proven reciprocating piston principle** as the standard truck engine. This husky unit, like the brake valves, governor, brake chambers and all other Bendix-Westinghouse components, has demonstrated its **unsurpassed durability** time after time with many, many miles of rugged, reliable trouble-free service. It is this sturdy construction . . . simplicity of design . . . and ease of maintenance that truly makes these mighty brakes the logical choice for Ordnance vehicles everywhere. Take advantage of it. Get a **proven system** by specifying smooth-acting Bendix-Westinghouse — the world's most tried and trusted air brakes!

BENDIX-WESTINGHOUSE AIR BRAKES
REG. U.S. PAT. OFF.

THE BENDIX-WESTINGHOUSE COMPRESSOR— heart of the air brake system—performance proven over more miles on more installations than any other compressor available!

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • ELYRIA, OHIO • BERKELEY, CALIF.

How their coordination brings you better steel and steel products

Whether you need steel fabricated to order, or end products of steel, there's a good reason why you get a better product at less cost when you work with this team of steel specialists.

For the members of this team represent the member companies of Barium, the steel producer that ranks first in *diversity* . . . making more kinds of fabricated steel articles and end products than any other steel company.

This means that Barium has more specialized skills in more phases of steel making and fabricating to apply to your order. You get the benefit of experts, using the best and most economical methods to solve any problem your order presents. Barium can take advantage of geographical locations and production facilities of any of its member companies and dovetail their operations to produce the best product for you at the lowest possible cost.

And your order is handled *entirely* within the Barium family. There's no sub-contracting. You get unit responsibility . . . on quality (controlled by Barium from blast furnace to end product) . . . and on deliveries (no "outsiders" to cause delays).

Let Barium's diversified engineering, research and development skills serve your steel needs . . . just as they serve the vital requirements of the Armed Services and American industry, today as in World War II. Address your inquiry to Barium Steel Corporation at 25 Broad Street, New York City.

BOLTS — Bayonne Bolt Corporation

STEEL PLATE — Central Iron and Steel Company

PIG IRON — Chester Blast Furnace

CRANES AND HOISTS — Clyde Iron Works, Inc.

SPRINGS — Cuyahoga Spring Company

BOLTS AND NUTS — Erie Bolt and Nut Company

METAL STAMPINGS — Geometric Stamping Company

DROP FORGINGS — Globe Forge, Inc.

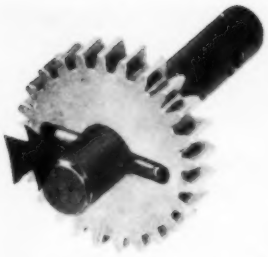
HEAVY FLAT DIE FORGINGS — Industrial Forge and Steel, Inc.

AIRCRAFT ENGINES AND PRECISION ASSEMBLIES — Jacobs Aircraft Engine Company

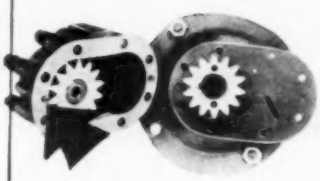
MARINE DIESEL AND GASOLINE ENGINES — Kermath Manufacturing Company, Kermath Limited (Canada)

STRUCTURAL SHAPES AND STEEL FABRICATIONS — Phoenix Bridge Company, Phoenix Iron and Steel Company

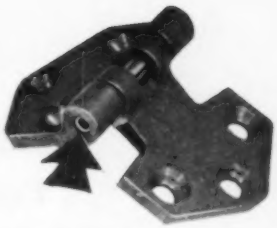
BARGES AND TUGS — Wiley Manufacturing Company



REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. This application, by Ditto Inc., effects major savings in assembly. Rollpin's high shear strength is particularly valuable here.



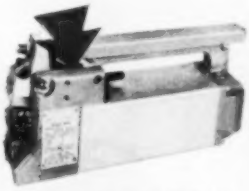
REPLACING A MACHINED PIN . . . In the lubrication pump assembly of the Cummins HR-400 diesel engine, two Rollpins are used as positioning dowels. Rollpins are self-retaining in production-drilled holes . . . quick to assemble and easy to remove.



REPLACING A HEADED PIN . . . In this hinge pin application, Rollpin is simply and inexpensively driven in place, greatly reducing assembly costs. Constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.

REPLACING A SET SCREW . . . Paper feed rollers are quickly, economically pinned to shaft by Rollpins in this office machine made by Ditto Inc. Flush fit affords neat appearance . . . spring tension assures positive, permanent positioning of rollers.

REPLACING A RIVET . . . Rollpin serves as guide shaft for spring-loaded electrical interlock contacts. The Square D Company reports that rivet failure previously occurred at the clinched end under normal operating impact and vibration.



REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots for the linkages in this Miller Electric Welder. Rollpins may be used with a free fit in outer or inside members depending upon product design requirements.

6 more examples of assembly-time saving with ROLLPIN

TRADE MARK

Rollpins are slotted, tubular steel, pressed-fit pins with chamfered ends. They drive easily into holes drilled to normal tolerances, compressing as driven. Reaming, tapering, extra assembly steps are eliminated. Rollpins are *locked* in place by the constant pressure they exert against hole walls. Inserted with an automatic press or by hand, Rollpins are readily removable with a drift or pin punch—and reusable again and again.

Elastic Stop Nuts with the famous red collar are another ESNA® product

FOR DESIGN INFORMATION—fill out and mail our coupon. If your plans include applications similar to those on this page—or clevis pins, keys, taper pins or stop pins—you can't afford to be without details on how much faster and cheaper Rollpin can do the job.

Dept. R6-929, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free information on ESNA self-locking fasteners:

☐ Rollpin bulletin and sample Rollpins ☐ AN-ESNA conversion chart
☐ Elastic Stop Nut Bulletin ☐ Here is a drawing of our product. What fastener do you recommend?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____

This truck is really geared
For the jobs it has to do;
It's built for rugged duty.....
Please note this worm's-eye view.
Definitely an EAGER BEAVER
KEEP YOUR GUARD UP!
JOIN THE NATIONAL GUARD

REO MOTORS, INC., Lansing 20, Michigan

Have you tried this acid-detergent method for removing rust and oil at the same time?

Here is what users are saying about Oakite Compound No. 33

MICHIGAN: "Removing rust for less than 9 cents per wheel; sand blasting cost 25 cents."

TEXAS: "Eliminates practically all rejects and also handwiping of booster caps."

NEW YORK: "Have never seen such clean parts with such perfect paint adhesion . . . Putting Oakite Compound No. 33 in specification sheets for sub-contractors on these registers."

ILLINOIS: "Works a miracle taking heavy rust off steel cabinets."

PENNSYLVANIA: "Well pleased with removal of drawing compound, heat scale, rust and oil. Parts coming through good and clean."

CALIFORNIA: "This material is a beauty . . . one we've been waiting for on this jeep overhaul job."

MICHIGAN: "Removes oil, rust and scale faster . . . Increases adherence of rubber to steel for motor mounts and bumpers."

MASSACHUSETTS: "Removed carbonized smut and scale from rocket parts perfectly in 8 minutes."

MISSOURI: "Results very good. All corrosion removed from battery connectors."

OHIO: "Eliminated one wiping operation . . . Paint really sticks on metal caskets."

NEW YORK: "Beautiful job . . . Removes residues from steel transformer cases . . . eliminates one operation. Delighted with saving. . ."

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

Metal craftsmen using Oakite Compound No. 33 say it is just what they've been looking for: a metal-cleaner that combines three important operations into one:

1. **It removes rust** *at the same time that*
2. **It removes oil** *at the same time that*
3. **It prepares the metal for painting**

Oakite Compound No. 33 removes rust, heat scale, tarnish, other oxides, stamping and forming oils, rust preventives, carbon smuts, soldering and welding fluxes, identification inks and similar soils. It develops excellent paint adhesion on steel, cast iron, aluminum sheet and castings.

For Use in Tanks or by Hand—Oakite Compound No. 33 is great for soak-cleaning metal parts of moderate size; and great for hand-swabbing on large metal surfaces.

Often Avoids Pickling—Oakite Compound No. 33 removes rust and oil so successfully that it frequently eliminates the need for a cycle of separate cleaning, pickling, neutralizing and paint-conditioning operations. It saves money in many ways.

FREE For a copy of "*New metal cleaner removes oil and rust in one operation*"—describing the use of Oakite Compound No. 33—just drop us a note or mail the coupon.

OAKITE PRODUCTS, INC.
26 Rector St., New York 6, N. Y.

Send me a FREE copy of "*New metal cleaner removes oil and rust in one operation*"

Also, send me information about Oakite methods for the following jobs:

- ☐ Tank cleaning
- ☐ Electrocleaning steel
- ☐ Electrocleaning non-ferrous metals
- ☐ Machine cleaning
- ☐ Pickling
- ☐ Steam-detergent cleaning
- ☐ Pre-paint treatment
- ☐ Paint stripping
- ☐ Burnishing
- ☐ Rust prevention

NAME_____

COMPANY_____

ADDRESS_____

A regular "busybody" around your plant

Sticks Its Nose into Any Material-Handling and Excavating Work . . . . And Gets the Job Done Fast

Allis-Chalmers HD-5G

1 cu. yd. Bucket, 40 drawbar hp. Dumping Height — 9 ft., ¼ in.

Interchangeable attachments include: Special buckets — up to 2-yd . . . Bull-dozers for excavating and backfilling . . . Crane Hook for heavy lifting . . . Lift Fork for handling palletized loads . . . Trench Hoe for footings, pipe — other trenching.

Bulk Materials — Wades Right Into Any Stockpile — Indoors or Out

. . . scoops out and carries a full cubic yard at a pass. Only a crawler tractor gives you the traction and power you need for tough digging as well as material handling . . . and the flotation for really heavy going. And only this A-C crawler gives you an extra, fast reverse to increase output, plus 1,000-hour lubrication of truck wheels to save you 30 minutes' greasing time every day.

Coal — Stores, Compacts and Reclaims

This flexible unit can build stockpiles in any available space. Ability to spread and pack coal in thin, horizontal layers eliminates flues — the main cause of spontaneous combustion. Standard track shoe eliminates coal breakage. As coal is needed, the HD-5G quickly loads from stockpile to trucks. On short hauls, it dozes or carries coal directly to plant.

Waste — Cleans Up and Loads

Out in the yard, this busy tractor cleans up and loads industrial waste, excavates, trenches and backfills on new construction, spots cars, clears snow . . . handles many other jobs winter and summer.

1-Yd. HD-5G — 40 drawbar hp.

2-Yd. HD-9G — 72 drawbar hp.

3-Yd. HD-15G — 109 drawbar hp.

4-Yd. HD-20G — Torque Converter Drive, 175 net engine hp.

Now . . . to meet the challenge of ever-increasing production demands, Allis-Chalmers multiplies its scope of tractor usefulness even more. And here's how. The same basic design . . . the same versatility that make the HD-5G Tracto-Shovel so useful is now available on all four models of modern Allis-Chalmers tractors.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

Ready to Warn Americans at a Moment's Notice!

Paul Revere's famous ride April 18th, 1775, warned Americans of impending attack.

CHRYSLER AIR RAID SIREN

- **Sounds Loudest Warning ever produced**
- **Has independent power**
- **Can be remote-controlled**
- **Cost less for complete coverage**

Today, Chrysler Air Raid Sirens are standing ready to warn American cities and towns in case of attack.

These sirens produce the loudest warning sound ever achieved by modern production. They are independently powered by the revolutionary new 180 horsepower Chrysler V-8 Industrial Engine. This great engine is the only power needed to motivate the Siren. When operating at full speed the Chrysler Siren has a range of four miles.

Chrysler Air Raid Sirens can be remote-controlled from a hidden central control station, or may be manually operated at the location site. Chrysler Sirens offer greatest coverage with the least number of sirens. More sound carries over a wider area.

For complete information, specifications and availability of this most modern warning device, write Siren Layout Service, ***Marine and Industrial Engine Division, Chrysler Corp., Trenton, Michigan.***

Civil Defense is a common need, shared by all. Help yourself to preparedness. Join the Civil Defense group in your area.

CHRYSLER
AIR RAID SIREN

GITS *Unit** SEAL
Now STANDARDIZED

For . . .

Gear Reduction Units
Aircraft Reciprocating Engines
Automotive Accessories
Jet Propulsion Units
Washing Machines
Standard & Special Machine Tools
Electrical Power Equipment
Business Machines

If *you* have a shaft sealing problem, Gits experience in these and many other specific applications can prove of great and immediate value to you.

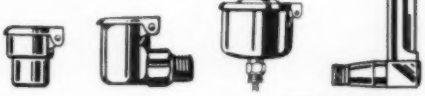
Write today for FREE illustrated Brochure, or send us your seal problem.

*Cartridge Seal . . . pressure balanced . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1842 S. Kilbourn Ave. • Chicago 23, Ill.

Gits Lubricating Devices,
The Standard For Industry For Over 40 Years



FOR

CHOOSE EQUIPMENT WITH

CONTINENTAL RED SEAL POWER

CONTINENTAL MOTORS · AMERICA'S STANDARD · Powerful as the Nation

Today's

BROAD AND DIVERSIFIED LINE
OF
CONTINENTAL RED SEAL ENGINES
INCLUDES SOME 80 BASIC MODELS,
BUILT TO MORE THAN
2,000 DIFFERENT SPECIFICATIONS
FOR COUNTLESS APPLICATIONS
ON LAND, AT SEA
AND IN THE AIR

PARTS AND SERVICE EVERYWHERE

Continental Motors Corporation
MUSKEGON, MICHIGAN

Why can't this be an ALUMINUM DIE CASTING?

This challenge was thrown at us by a leading automobile maker.

"It's possible," we agreed. But . . . the clutch housing also supports half the engine's weight, it is highly stressed, must absorb vibration. Could a die casting economically be made that strong?

An Alcoa Development Program was started. With the auto maker we drew up designs. We selected our strongest die casting alloy; poured *sand castings* from it; machined it to the dimensions of the die casting design.

Shear static loads and bending stresses were measured. Brittle lacquer and strain gages show us stress concentrations. Castings, engine and transmission were assembled, then run with an unbalanced shaft to measure dynamic stresses.

With the auto maker we modified designs. Die castings were made. We repeated the laboratory tests while the auto maker made road tests. The first stressed automotive die casting was a success. 25% stronger in shear, 10% stronger in bending, 100% better in fatigue life than the original clutch housing. Only ¼ as much weight as the original cast-iron housing. *And 15% lower in cost.*

This case is typical of the engineering problems Alcoa men undertake and solve. The same research, test and development facilities stand ready to help you make the best possible use of aluminum for defense needs.

ALUMINUM COMPANY OF AMERICA
850-J Gulf Building • Pittsburgh 19, Pennsylvania

A business built on co-operation

ALCOA®

ALCOA

ALUMINUM COMPANY OF AMERICA

Along the
BLAW-KNOX "FIRING LINE"

Shown here are tank turrets emerging from a heat-treating furnace in a Blaw-Knox plant devoted almost exclusively to armor castings. Today, as in previous emergencies, Blaw-Knox gives top priority to Defense production . . . supplies urgently needed material and equipment for fighting, for protection, for transport, for many other functions of the nation's preparedness program. The Blaw-Knox "firing line" can be counted on for full support to our Armed Forces.

BASIC PRODUCTS FOR INDUSTRY

- ★ Rolls for Steel & Non-Ferrous Mills
- ★ Rolling Mills & Auxiliary Machinery
- ★ Open Steel Flooring
- ★ Prefabricated Piping Systems
- ★ Open Hearth Furnace Equipment
- ★ Fire Protection Equipment
- ★ Chemical & Food Processing Equipment
- ★ Concrete & Asphalt Road Paving Machinery
- ★ Complete Chemical & Processing Plants
- ★ Radio, Television & Transmission Towers
- ★ Heavy Steel Castings
- ★ Heat & Corrosion Resisting Alloy Castings
- ★ Steel Forms for Concrete Construction
- ★ Contractors Equipment
- ★ Clamshell Buckets

BLAW-KNOX COMPANY*

2127 FARMERS BANK BUILDING • PITTSBURGH 22, PA.

A Pacemaker for American Initiative and Ingenuity

OPERATING AND SALES DIVISIONS—Blaw-Knox • Buflovak Equipment • Buflovak Midwest Co. • Chemical Plants* • The Foote Company, Inc.** • Lewis Foundry & Machine • National Alloy Steel • Pittsburgh Rolls • Power Piping and Sprinkler* • Union Steel Castings

*Operates as a division of Blaw-Knox Construction Co. **Subsidiary of Blaw-Knox Co.

★AWARDED SEVEN "E's" DURING WORLD WAR II

RECENT CATALOGS AND BULLETINS detailing practically all Blaw-Knox products are available, and any literature you request will be forwarded by return mail.

Every Facility For Producing, Machining,

ARMOR

WELDED FABRICATION OF SUBASSEMBLIES . . . . . ANOTHER STANDARD STEEL SPRING COMPANY SERVICE

The sparks are flying in many of our plants where armor plate is being subassembled for customers with pads welded in place, etc. This is an additional service made possible through the diversified talents of our subcontractors. It helps speed the production of armored vehicles, lowers costs and spreads the work load.

Standard Steel Spring Company • ARMOR PLATE DIVISION

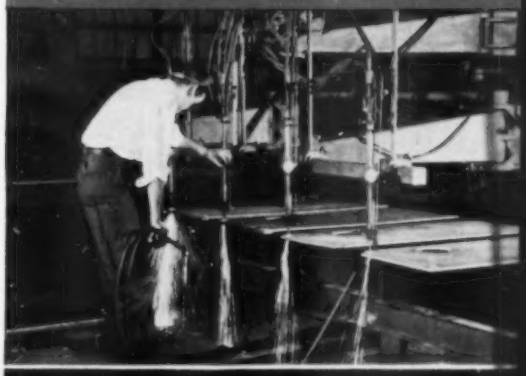
Fabricating . . .

PLATE for Ordnance

Our integrated group of subcontracting plants is staffed and equipped to turn out armor plate in huge volume. Whether your needs are for large or small parts in flat, blanked or formed shapes — heat treated, fully machined, even subassembled — we have unexcelled facilities and the know-how to do the work with dispatch and to exacting quality standards.

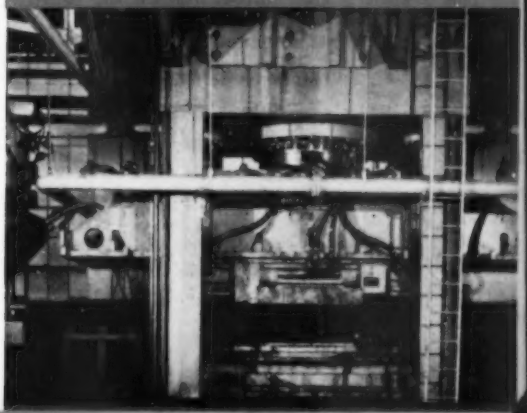
Our services include *everything* — from engineering the parts, through procurement and tooling, to expediting and final inspection. You'll save time and money, gain every production assist when you address your armor plate inquiries to us.

Forming and heat treating bay in typical subcontractor's plant



Multi-cutting torch arcwer with torch guided by Tracergraph

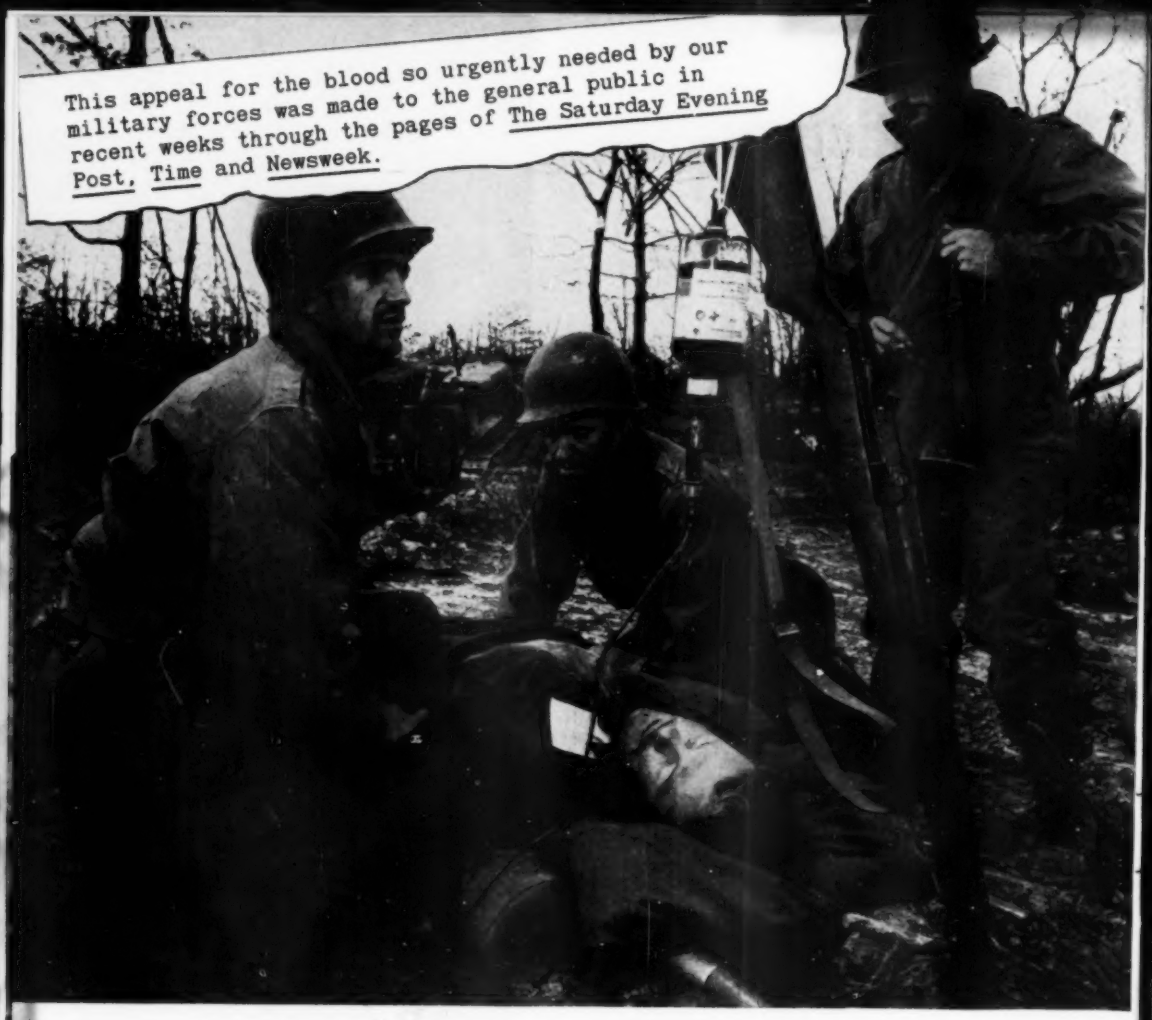
Edge grinding armor plate with rail mounted machine



2500 ton press used in quenching and forming operations

SSS

PENOBSCOT BLDG. • DETROIT, MICHIGAN


This appeal for the blood so urgently needed by our military forces was made to the general public in recent weeks through the pages of The Saturday Evening Post, Time and Newsweek.

Lifeline

This is where it goes. To this scorched and battered hole it brings the miraculous, life-giving drops that rob death of one more mother's son.

It started—where? In a New England mill town, perhaps. Or a port city on the Gulf. Or a village deep in the midwestern prairie. He will never know—this boy whose life it saves.

But he will know forever that somewhere in the great heartland of America someone thought of him, and gave that he might live.

Now . . . who will tell him the other side of the story? Would *you* care to tell this boy and his comrades their life line is running dry?

The fact is, today's needs are many times greater than available reserves—reserves which must keep pace with the growing strength of our armed forces if the appeal for blood is to be met adequately. It's as plain as that.

Science and medicine perform miracles . . . but miracles cease when charity fails.

No longer is this a job for the thoughtful few. It is a job now for every single one of us. Get in touch with your local chapter of the Red Cross *now*. Give your share . . . *now*.

Together, with the help of God, we can keep the life line going.

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

IF THE PART IS TUBULAR—

DRAW ON THE SPECIALIZED FACILITIES OF WOLVERINE TUBE and PRODUCE IT IN MINIMUM OF TIME and WITH MINIMUM MATERIAL!

Today, when materials must be conserved—especially copper—and there is a never-ending cry for needed products, making speed in production also an important factor—there is a distinct advantage in producing tubular parts the Wolverine way.

Many steps in production have been saved in this way—in several instances, material has been reduced and a number of operations have been eliminated. That meant a two-fold saving. Moreover, some of the resulting new designs have also proved more functional.

The products shown here are a few taken at random from our voluminous file to give you an idea of the wide range of the fabricated tubular parts we have developed. By availing yourself of our specialized experience, you can save yourself many false moves and arrive at the solution to your particular problem quicker and more conveniently.

No obligation to call in our engineers.

WOLVERINE TUBE DIVISION

Calumet and Hecla Consolidated Copper Company
INCORPORATED

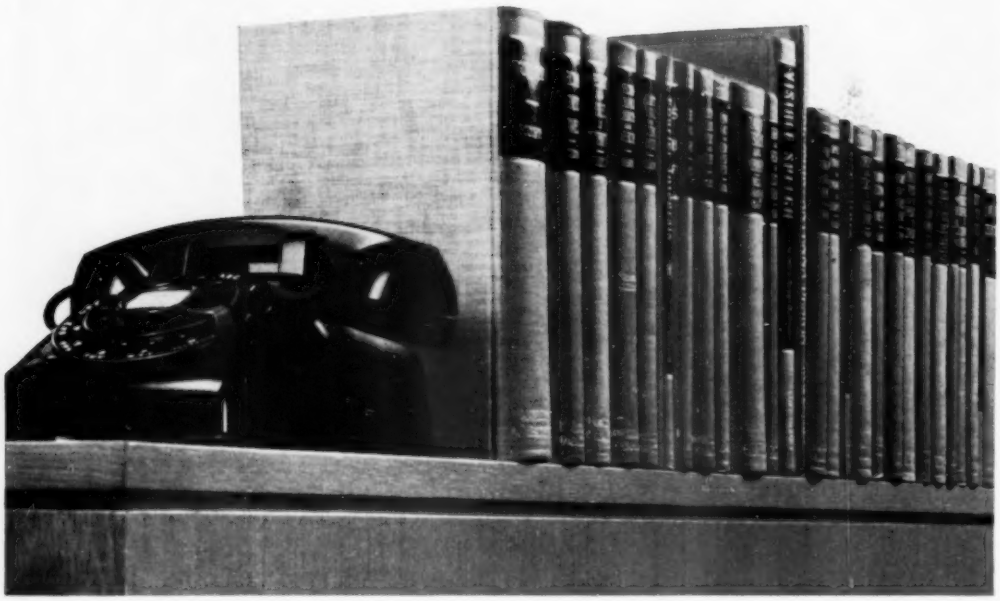
Manufacturers of Tubing Exclusively

1467 Central Avenue • Detroit 9, Michigan

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N.Y.

Telephone Science Shares Its Knowledge



The Bell Telephone Laboratories Series of books is published by D. Van Nostrand Company. Other technical books by Laboratories authors have been published by John Wiley & Sons. Complete list of titles, authors and publishers may be obtained from Publication Dept., Bell Telephone Laboratories, New York 14.

List of Subjects: Speech and hearing, mathematics, transmission and switching circuits, networks and wave filters, quality control, transducers, servomechanisms, quartz crystals, capacitors, visible speech, earth conduction, radar, electron beams, microwaves, waveguides, traveling wave tubes, semiconductors, ferromagnetism.

In their work to improve your telephone service, Bell Laboratories make discoveries in many sciences. Much of this new knowledge is so basic that it contributes naturally to other fields. So Bell scientists and engineers publish their findings in professional magazines, and frequently they write books.

Most of these books are in the *Bell Telephone Laboratories Series.* Since the first volume was brought out in 1926, many of the books have become standards . . . classics in their fields. Twenty-eight have been published and several more are in the making. They embody the discoveries and experience of one of the world's great research institutions.

Bell scientists and engineers benefit greatly from the published findings of workers elsewhere; in return they make their own knowledge available to scientists and engineers all over the world.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides challenging opportunities for individual achievement and recognition in scientific and technical fields.

ORDNANCE DESIGNERS:

Are you designing—

Engines • Lifts

Vehicles • Transmissions

Hydraulic Steering

Give you these important advantages

Silent Operation • Compact Design • Dry Priming

High Efficiency at all Speeds

for

Servo Power • Lubrication • Cooling

Liquid Transfer • Maintaining Pressure

Illustrated literature upon request

EATON MANUFACTURING COMPANY

GENERAL OFFICES: CLEVELAND, OHIO

Pump Division

9771 FRENCH ROAD • DETROIT 13, MICHIGAN

may be buried in your scrap pile!

The steel foundries and mills of America are *hungry* for scrap. Defense production is slowing down for lack of it.

Tanks and guns and planes may be missing *from* action, if precious scrap is allowed to *rust* in peace in the graveyards of industry.

Scrap may not be *quite* worth its weight in gold, but it's worth *half* its weight in good new steel! It takes a *ton* of ferrous scrap to produce two tons of steel. And it takes over *36 million* tons to meet our goals for 1952.

Let's get it! Let's rout out the busted boilers, rails, gears, chain, dies, jigs, machine parts, and obsolete tools. Let's do it *now* . . . this is no job to put off 'til tomorrow.

Let's give defense production a *lift* . . . while we turn useless, forgotten *junk* into vitally needed products!

ASF *American Steel Foundries*

MINT MARK OF ○ FINE PRODUCTS

410 N. Michigan Ave., Chicago 11, Ill.
Canadian Sales: International Equipment Co., Ltd., Montreal, Quebec

This pocket size book briefly describes and illustrates Clark Products. You are invited to send for it.

The Stuff of Which Champions are Made...

THE CLARK DRIVE UNIT

On countless heavy duty assignments you find them—on farms, construction projects, road jobs: machines that are performing dependably and efficiently with CLARK designed transmission-axle units.

Here, indeed, is the stuff of which champions are made—simple designs developed out of CLARK's unique experience in the field of transmitting motive power; and rugged, too!

A number of leading manufacturers of agricultural and industrial equipment have used CLARK Engineering in designing new machines or redesigning old ones. This can be said: The results have been uniformly good.

PRODUCTS OF CLARK — TRANSMISSIONS • AXLES • AXLE HOUSINGS • TRACTOR DRIVE UNITS • FORK TRUCKS AND TRACTORS • POWERED HAND TRUCKS • GEARS AND FORGINGS • ELECTRIC STEEL CASTINGS

CLARK EQUIPMENT COMPANY • BUCHANAN, MICHIGAN

Other Plants: BATTLE CREEK *and* JACKSON, MICHIGAN

Here's the time-proved torque converter for heavy service

—a compact, efficient torque converter and fluid coupling available for heavy-duty engine and equipment manufacturers

ALLISON—builder of more than 10,000 Torqmatic Transmissions for military vehicles—offers American industry this proved torque converter. It enables heavy-duty equipment to get more work done faster—with less wear and tear on equipment and less operator fatigue.

A combination torque converter and fluid coupling, the new Allison TORQMATIC CONVERTER gives heavy off-highway trucks and other power machinery the smoothness and operating ease you enjoy with a hydraulic transmission in your car. It makes practical multiple engine installations in heavy vehicles.

The TORQMATIC CONVERTER multiplies torque automatically, providing an efficient balance between engine power and changing load demands. This eliminates engine lugging and stalling — permits the engine to operate in its most effective speed range.

It also prevents shock-loading of drivelines, cables, shafts, chains, gears and axles—reduces maintenance—lengthens equipment life.

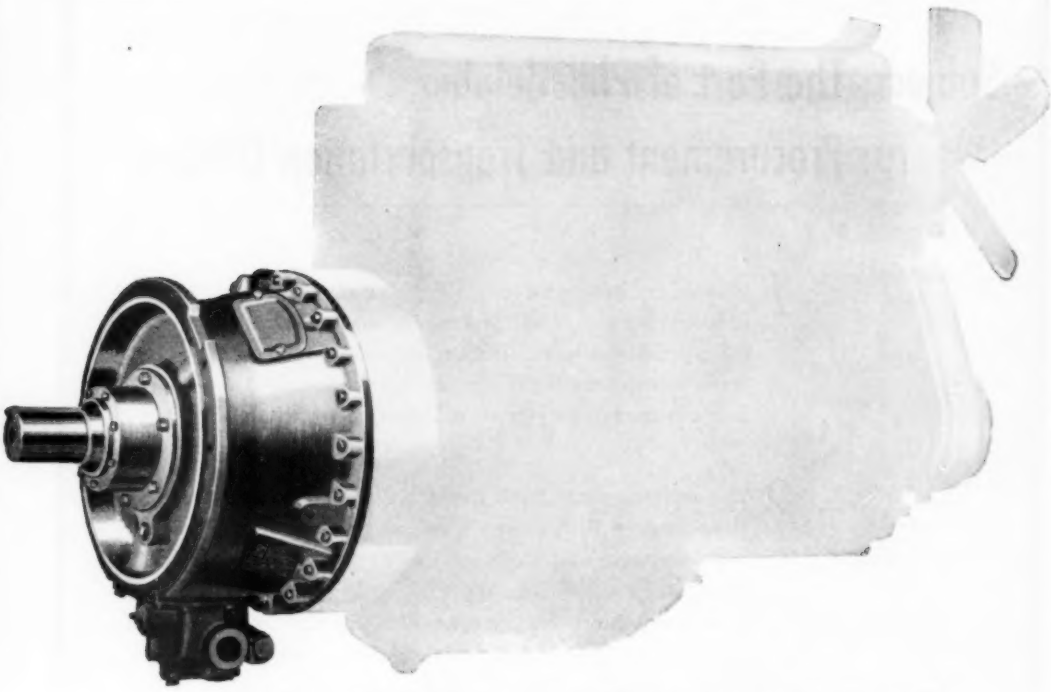
Wide Flexibility

Allison TORQMATIC CONVERTERS have been applied successfully with many engines in a variety of heavy-duty equipment — trucks, tractors, earth movers, industrial locomotives, rail cars, hoisting machinery, logging equipment, drilling rigs and pumps.

In each of these applications, the TORQMATIC CONVERTER has proved its ability to get the most work done in the shortest possible time.

Allison TORQMATIC CONVERTERS furnish ideal drives for heavy-duty engines delivering 75 to 350 horsepower. These compact units take no more space than a conventional, clutch-type, power take-off. For further information write to:

ALLISON DIVISION of GENERAL MOTORS
Box 3940, Indianapolis 6, Indiana



Here's how Allison Torqmatic Drive pays off:

More work output—eliminates "gearshift guess," multiplies torque hydraulically. Automatically balances engine power with changes in load demand.

Handles heavy loads—with shock-free, pinpoint control.

Longer equipment life—increases life of drivelines, axles, chains, sprockets and gears. Reduced wear and tear on equipment means higher availability.

Longer engine life—no engine lugging or stalling—reduces shock-loading on engine and components.

Few moving parts—simplified design with one-piece cast converter elements—easy to maintain.

Compact design—simplifies installation.

- Designed for power application from 75 to 350 h.p.
- Wide variety of models including industrial shafts, automotive type flanges, dis-connect clutches, lock-up clutches, output shaft governor drive.

GM
GENERAL MOTORS

Allison
TORQMATIC DRIVES

Subject: The Port of Philadelphia
To: Procurement and Transportation Officers

1 What is now being produced in the 8,000 plants located in the Delaware basin is of the greatest importance to the nation's military effectiveness. Procurement and transportation officers are keenly aware of the extent to which this vast industrial area has been converted into a gigantic and widely diversified arsenal.

•

2 This productive capacity is served, and made possible, by the Delaware River Port, where sea, rail, and highway meet to produce everything to facilitate shipping to and from the world's ports. Direct ship-train or ship-truck transfers make lighterage unnecessary. Room here for 147 ocean-going ships to load and unload at one time. Ample facilities for heavy cargo handling.

•

3 The inland location of Philadelphia, heart of the Port, provides an added measure of protection. It also shortens the distance to inland production centers. Overnight service to areas containing half the country's industrial capacity.

•

4 Transportation officers, routing their shipments "*via Philadelphia*," are increasingly making use of this, the best-equipped and fastest growing port in the nation.

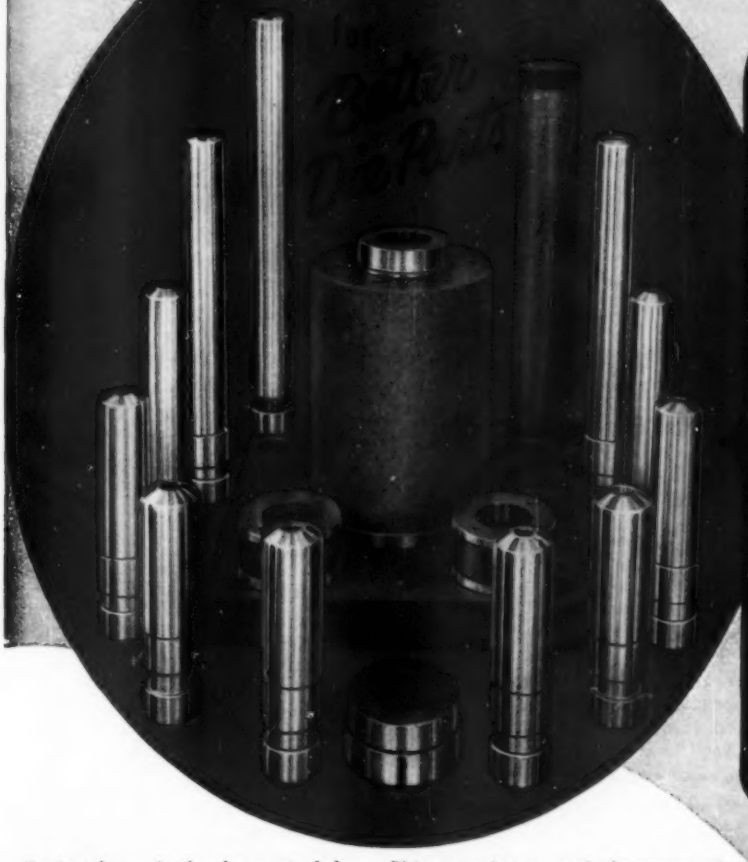
DELAWARE RIVER PORT

PHILADELPHIA • CAMDEN • TRENTON • CHESTER • WILMINGTON

Questions will be promptly answered by the Delaware River Port Authority, Bridge Plaza, Camden 2, N. J.

ADVANCE TOOLING...

combines EXPERIENCE, KNOWLEDGE and SKILL



Punches and Die Parts for 75 MM, 90MM & 105MM STEEL CARTRIDGE CASES

During the early development of the steel cartridge case in this country, Advance Die & Tool engineers were able to assist in the tooling for those parts. A wealth of experience and knowledge was gained about die materials, their physical characteristics, treatments and finishes required for proper surface conditions. Many thousands of punches and die parts were made at that time.

This experience again becomes of value in producing superior quality punches and die parts for manufacturing steel cases from 20 MM and up. Our modern plant includes facilities for heat and deep-freeze treatment of tool steel parts that make certain the best possible physical properties. Polishing and buffing set-ups provide the necessary surface finish of all parts. Skillful and efficient operations assure you prompt deliveries.

Write For Bulletin Illustrating Advance Facilities

ADVANCE DIE & TOOL CO.

6800 MADISON AVENUE CLEVELAND 2, OHIO

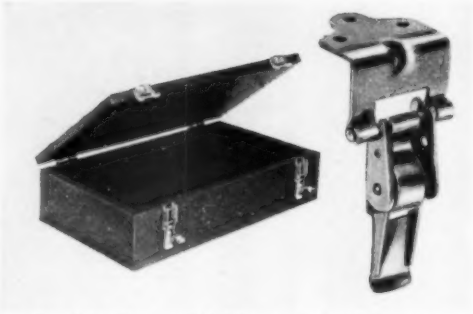
PHONE: WOodbine1-9191

Have you a fastening or clamping problem?

IF YOU HAVE, CHANCES ARE BASSICK HAS A DEVICE TO SOLVE IT

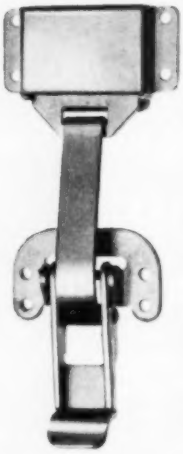
Catches and fasteners, for everything from jeep hoods to tool boxes, kits, and containers, are available from Bassick . . . either "standard", like the four shown, or adaptations to meet your special needs by Bassick development engineers working with you.

For many years, Bassick has been a leading supplier of specialty hardware to the automotive and other top industries . . . in addition to being the world's largest manufacturer of casters.



Combination Latch-Hinge (ZLA-1020, ZLA-1009)

A truly versatile fastener! Clamps on one side in locked position are acting as hinges, while the clamps on the other side are open, permitting entrance to the box, which can be opened from either side. Lid easily removed by unlocking all four fasteners.



Back View

"Power-Pack" (ZLA-1104)

This behind-the-catch view shows why this clamp won't loosen even under the roughest handling or vibration. There are *100 lbs. of tension* compressed in these springs, but it is not a "knuckle breaker"! Ideal for operation in sub-zero temperatures.

Flush Type Clamp Assembly

(ZLA-1098)

These clamps are fully recessed to allow close stacking of the crates, boxes, etc., on which they're installed. Arm is spring-loaded to work easily and grip the latch firmly. Hole for inserting padlock or shipping seal.

Heavy-Duty Hood Fastener

(C-4017)

"Catching" vehicle hoods is but one of the many uses for this type of fastener. It always provides a dependable and economical "hold", yet allows easy access to encased units. Bassick makes many sizes and styles.

Write for Specialty Hardware Catalog, showing our extensive line, or address your problem to THE BASSICK COMPANY, Bridgeport 2, Conn. *In Canada*: Belleville, Ont.

Bassick

A DIVISION OF STEWART SW WARNER

MAKING MORE KINDS OF CASTERS . . . MAKING CASTERS DO MORE

MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
N·A·X
HIGH-TENSILE STEEL
... And
"MAKE YOUR PRODUCT LAST LONGER"

Containers and pressure vessels assure greater service when made of N-A-X HIGH-TENSILE steel. The durability of this low-alloy steel, its greater resistance to corrosion and abrasion, and its exceptional fabricating and welding qualities are important characteristics. The greater strength of N-A-X HIGH-TENSILE steel permits fabrication of containers from thinner sections—reducing costly deadweight to a minimum. If you are interested in effecting economies in barrels, drums or cylinders, investigate N-A-X HIGH-TENSILE steel.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Mich.

NATIONAL STEEL CORPORATION

WHY USE 3 TO 5 TRUCKS... WHEN ONLY ONE WILL DO?

In many plants a Dempster-Dumpster, like the one above, operated by only one man, the driver, has replaced 3 to 5 conventional trucks and crews. The reason for this is that one truck-mounted Dempster-Dumpster serves scores of Dempster-Dumpster Detachable Containers up to four times the capacity of the average dump truck body. These containers are built in a wide variety of designs best suited to the type of materials handled—be they bulky, light or heavy . . . solids or liquids . . . trash or rubbish. Containers are conveniently located at accumulation points inside and outside buildings. To illustrate the flexibility of the Dempster-Dumpster System in handling all types of materials in your plant, we show, at right, a few of the dozens of Dempster-Dumpster Containers built to meet every bulk materials handling need. And remember, one truck-mounted Dempster-Dumpster handles all containers, regardless of capacity or design.

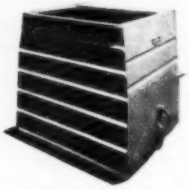
The Dempster-Dumpster System eliminates standing idle time of crews and trucks . . . eliminates re-handling of materials . . . increases efficiency, sanitation and good housekeeping . . . cuts cost of truck equipment and operation tremendously. Without question, it's the most efficient and lowest cost method of bulk materials handling by truck ever devised! The chances are this system will save you thousands of dollars annually. This equipment manufactured and sold exclusively by Dempster Brothers, Inc.

WHEN A CONTAINER IS FULL, the Dempster-Dumpster picks it up, hauls to destination and dumps the materials or sets load down intact. These three simple operations, shown above, are hydraulically controlled by driver in truck cab.

Drop Bottom Container built up to 10 cu. yd. capacity to handle heavy materials.

Tank Type Container meeting A.S.M.E. specifications. Capacities up to 1,200 gallons.

Tilt Type with Converged Lip for handling fine aggregate, wet or fluid materials.

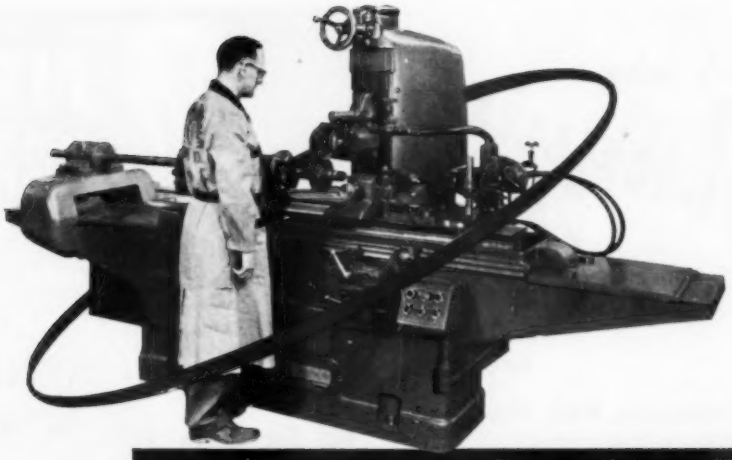


Drop Bottom Pressed Steel Type for lighter service.

Universal Type built up to 12 cu. yd. capacity with top and end doors.

Five cu. yd. container with swivel casters for handling waste blast sand.

DEMPSTER BROTHERS, 992 Shea Bldg., Knoxville 17, Tennessee



Indexing mechanism of the Helical Grinder

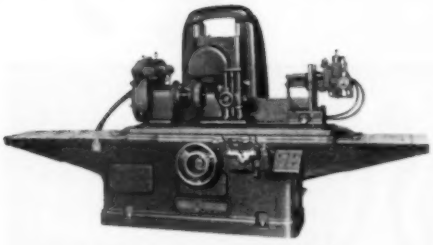
NEW HELICAL GEAR AND SPLINE GRINDER

Assures Highest Accuracy in both Lead and Tooth Form

The new Red Ring Helical Gear and Spline Grinder, Models SGF-12" and 18", incorporate the lead bar principle thus eliminating the inherent errors, human and mechanical, of conventional methods heretofore used to maintain specific lead or helix angle.

The lead of every gear tooth or spline is exactly alike—exactly the same as that of the precision ground master lead bar which rigidly controls the progressive rotation of the work part as it is traversed under the grinding wheel.

The grinding wheel is dressed to any desired tooth form. That form is controlled by a hardened steel master form plate which guides the movement of the dresser diamonds.



Red Ring Spur Gear and Spline Grinder, Models SGD-12" and SGC-18"

Write for descriptive folder on Red Ring Gear and Spline Grinders both helical and spur.

NATIONAL BROACH & MACHINE CO.

5600 ST. JEAN . . . . . DETROIT 13, MICHIGAN

WORLD'S LARGEST PRODUCER OF GEAR SHAVING EQUIPMENT

here's why

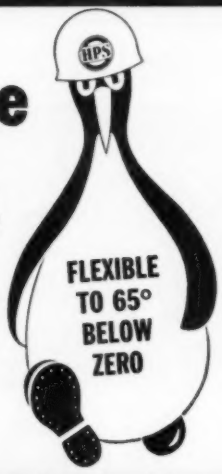
Penguin Pak

users

are Penguin Pak choosers:

FIRST
to meet
JAN-P-117
Grade A
Types I and 2
classes a • b • c

Positive
all around
HEAT SEAL
during
fabricating
and
final closure

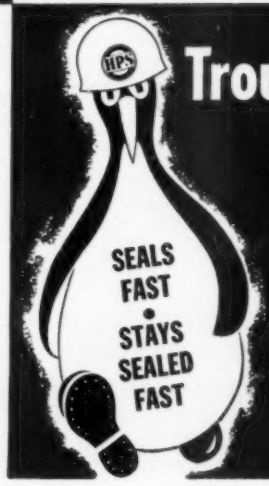


Bag and Pouch Users are specifying

Penguin Pak (Blue Stripe) because it more than meets requirements for fabricating, packing, inspection, and all-weather protection. Penguin Pak is thermal resin coated by the exclusive HPS "Loxol" Process. Complete protection is assured. Write for full information on the LOXOL process for protective wrapping. Be sure your next fabricating job has (Blue Stripe) Penguin Pak base stock.

H. P. SMITH PAPER CO.
MANUFACTURERS
IMPREGNATORS · LAMINATORS · FOIL · COATERS · PAPER · FABRIC

Specialists in Protective Barrier Materials
5001 West Sixty-Sixth Street, Chicago 38, Illinois



Trouble-Free
production
record
on high speed
bag and pouch
machinery

Lowest Cost Way TO DE-BURIZE up to 300 Gear Teeth per minute

Cut finished gear costs and raise output at the same time—with Sheffield #380 Series Gear Deburizers which offer the following advantages.

★ Burr or chamfer spur, helical, hypoid, bevel and herringbone gears, also, multiple start worms, up to 7" O.D. (Model #381 will handle gears from 6" to 12" O.D.)

★ Operate on automatic or continuous cycle generally without clamping the work gear.

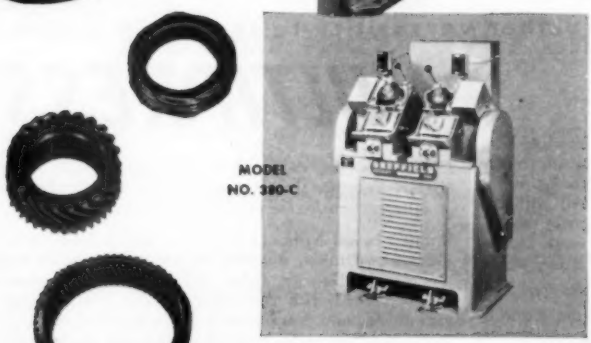
★ Use simple, low cost standard tool bits which are easily sharpened on the face angle only.

★ Interchangeability of tooling with minimum down time.

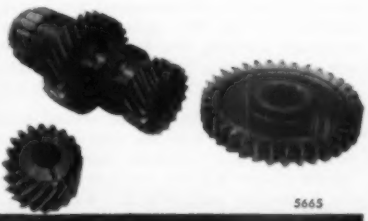
★ Small, compact, low cost machine requires minimum of setup and changeover time—and practically no maintenance.

★ Direct drive assures positive indexing.

Write for specifications #B-380-50 —or call your Sheffield Representative.



MODEL NO. 380-C

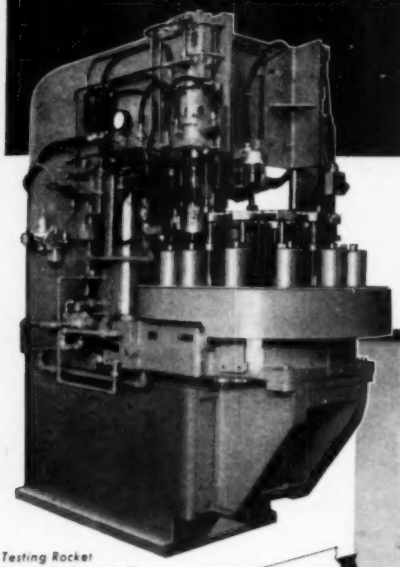


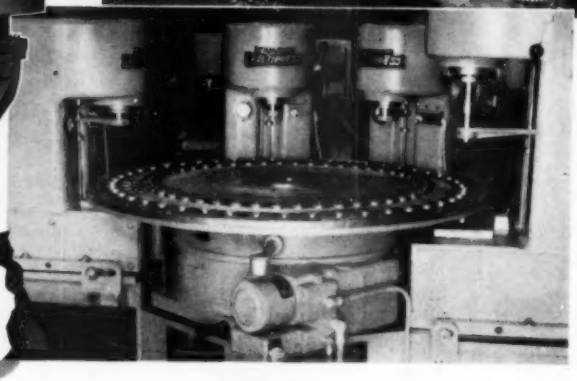
5665

Sheffield

DENISON INDEX TABLES

—multiply production speeds by faster *continuous* parts loading





Testing Rocket Bodies Hydrostatically— Automatically—

A Production Tip for Better Ordnance and Industrial Jobs

adds further versatility to the rapid action of

MULTIPRESS®

Thousands of Multipress users are daily proving—on both industrial and ordnance jobs—that automatic rotary feeding of parts is a sure way to speed up production . . . *and do it safely.* Synchronized and interlocked with the machine action, the table automatically turns, simultaneously carrying one loaded part to the work station and the preceding part on to the ejection station where it is either manually or automatically ejected.

As illustrated above, one or several operators working safely out of reach of the ram action, simply load parts or multiple-part assemblies into holding fixtures evenly spaced around the dial. No lost machine production time for loading or unloading the work in process!

Likewise, where the work requires progressive machine operations, more than one production unit can be placed at different work stations around the table.

Rotated by oil hydraulic power at speeds from 10 to 70 indexes per minute and available in six or twelve station models, the Denison Index Table has wide application. But combined with Multipress—with its wide range of ram action, and 8 frame sizes in capacities from 1 to 50 tons—you have a high speed production machine adaptable to almost unlimited application. One worthy of investigating today! Write.

It's Also An Ideal Rotary Feed For Other Types of Equipment!

DENISON *HydrOILics*

The DENISON Engineering Co.
1205 Dublin Rd., Columbus 16, Ohio

the war that never ends

The battle to transform generated power into the highest measure of applied traction is unending in the automotive industry. In this project, Spicer for 48 years has invented, developed and perfected power transmission units that have delivered outstanding performance in peace and war. We are dedicated to the service of the nation... helping to assure better, lower-cost transportation in the automobile, truck, bus, tractor, railway and airplane fields.

Designing, Developing, Engineering, Manufacturing and Service

Spicer

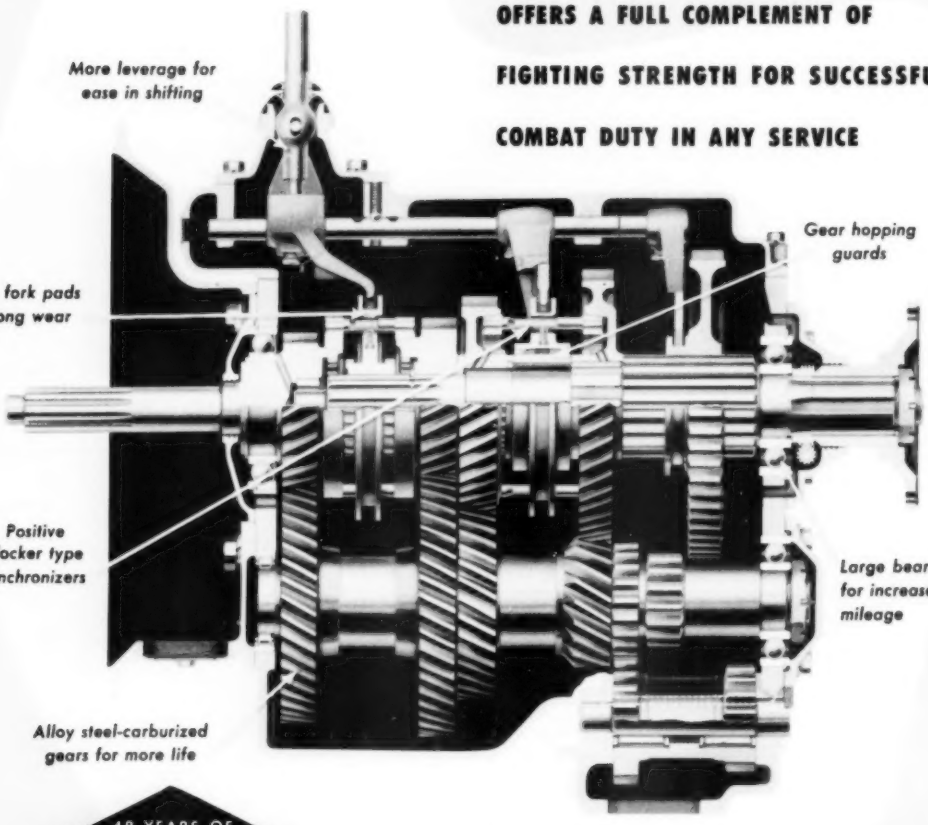
Spicer

SPECIALISTS IN SERVICE

Equal shifts for driver convenience

The Spicer Brown-Lipe Fully-Synchronized Transmission

OFFERS A FULL COMPLEMENT OF FIGHTING STRENGTH FOR SUCCESSFUL COMBAT DUTY IN ANY SERVICE


More leverage for ease in shifting
Gear hopping guards
Tocco fork pads for long wear
Positive blocker type synchronizers
Large bearings for increased mileage
Alloy steel-carburized gears for more life

48 YEARS OF Spicer SERVICE

SPICER MANUFACTURING

Division of Dana Corporation • **TOLEDO 1, OHIO**

TRANSMISSIONS • UNIVERSAL JOINTS • BROWN-LIPE AND AUBURN CLUTCHES • FORGINGS • PASSENGER CAR AXLES • STAMPINGS • SPICER "BROWN-LIPE" GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES

BRASS AND COPPER WIRE CLOTH

When you need Industrial Wire Cloth or Strainer Cloth, your nearest Chase Warehouse is the place to inquire for it.

Chase Brass and Copper Wire Cloth is made in meshes from No. 2 to No. 100 and in varying gauges for a wide variety of industrial uses. The mesh is uniform and the wires double crimped to keep openings square and true.

One of the 23 Chase Warehouses or the four Chase Sales Offices will give you full information on the type of wire cloth best suited for your production problem. Send the coupon below for free Chase book describing the full line of Chase Brass and Copper Wire Cloth.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Chicago	Denver†	Kansas City, Mo.	Newark	Pittsburgh	San Francisco
Atlanta	Cincinnati	Detroit	Los Angeles	New Orleans	Providence	Seattle
Baltimore	Cleveland	Houston†	Milwaukee	New York	Rochester†	Waterbury
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(†sales office only)

FREE Chase Book lists mesh, diameter of wire, per cent of open area, weight and other important data.

Chase Brass & Copper Co., Dept. OR9-1052
Waterbury 20, Conn.
Please send me your FREE book on Chase Brass & Copper Wire Cloth.

Name_____

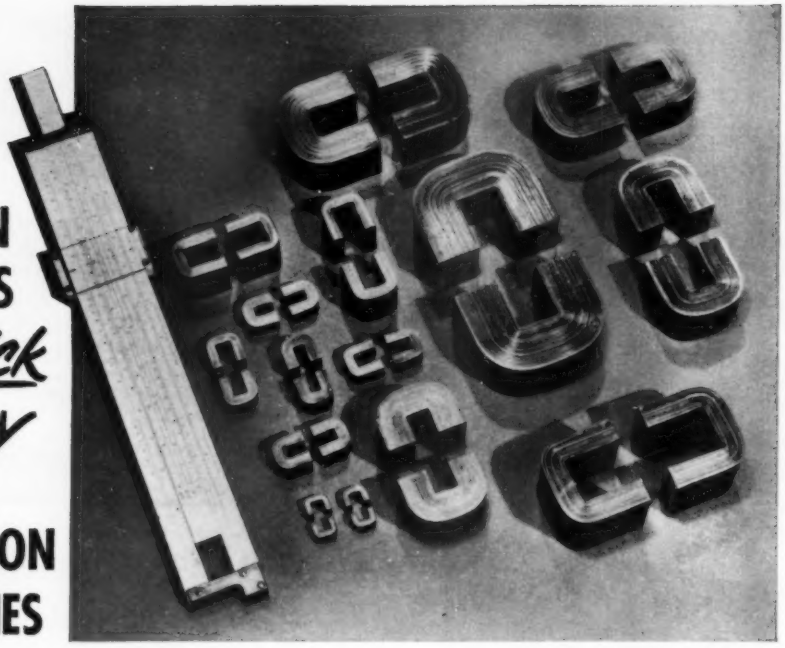
Position_____

Firm_____

Address_____

City_____ State_____

SILECTRON "C" CORES *for quick delivery* IN PRODUCTION QUANTITIES



. . . wound from strip as thin as 0.00025"

Quality-Tested and Proved

- ★ Arnold "C" Cores are made to highly exacting standards of quality and uniformity. Physical dimensions are held to close tolerances, and each core is tested as follows:
- ★ 29-gauge Silectron cut cores are tested for watt loss and excitation volt-amperes at 60 cycles, at a peak flux density of 15 kg.
- ★ 4-mil cores are tested for watt loss and excitation volt-amperes at 400 cycles, at a peak flux density of 15 kg.
- ★ 2-mil cores are tested for pulse permeability at 2 microseconds, 400 pulses per second, at a peak flux density of 10 kg.
- ★ 1-mil cores are tested for pulse permeability at 0.25 microseconds, 1000 pulses per second, at a peak flux density of 2500 gauss.
- ★ ½ and ¼-mil core tests by special arrangement with the customer.

Now available—"C" Cores made from Silectron (oriented silicon steel) thin-gauge strip to the highest standards of quality.

Arnold is now producing these cores in a full range of sizes wound from ¼, ½, 1, 2 and 4-mil strip, also 29-gauge strip, with the entire output scheduled for end use by the U. S. Government. The oriented silicon steel strip from which they are wound is made to a tolerance of plus nothing and minus mill tolerance, to assure designers and users of the lowest core losses and the highest quality in the respective gauges. Butt joints are accurately made to a high standard of precision, and careful processing of these joints eliminates short-circuiting of the laminations.

Cores with "RIBBED CONSTRUCTION"* can be supplied where desirable.

Ultra thin-gauge oriented silicon steel strip for Arnold "C" Cores is rolled in our own plant on our new micro-gauge 20-high Sendzimir cold-rolling mill. For the cores in current production, standard tests are conducted as noted in the box at left—and special electrical tests may be made to meet specific operating conditions.

● We invite your inquiries.

*Manufactured under license arrangements with Westinghouse Electric Corp.

W&D 4211

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

IGNITION SHIELDING

Complete harness assemblies with detachable unit leads or rewirable leads. Igniter or ignition lead assemblies for jet and reciprocating aircraft engines and military vehicles.

FLEXIBLE METAL TUBING

For electrical shielding, mechanical protection, fluid lines, conduits and ducts, pressure lines, and high and low temperature applications. Material, shapes and sizes to specification.

"AERO-SEAL" HOSE CLAMPS

Precision worm drive — for aircraft, automotive, marine, special-purpose and industrial use. Vibration-proof — will not work loose. Corrosion-resistant steel.

ACTUATING SYSTEMS

Electrical, mechanical, and hydraulic actuators for aircraft controls, valve closures, landing gear, or virtually any other type of equipment to manufacturer's specifications.

WELDED DIAPHRAGM BELLOWS

"Job engineered" to meet your requirements and make possible the use of bellows in applications where they could not previously be considered.

SPECIALIZED CONNECTORS

For electronic, aircraft, ordnance and communications equipment. Water-tight or pressure sealed types, panel types, quick disconnects, or other types for your new and special applications.

A Quarter Century of Design Experience backs BREEZE MARK products

You benefit from 25 years of engineering design and manufacturing experience when you call on Breeze for precision production. Breeze offers an extensive line of quality products for aviation, communications, automotive and general industry. In addition, Breeze offers complete engineering services for the design and development of specialized electrical and mechanical devices.

Breeze products meet the latest government specifications.

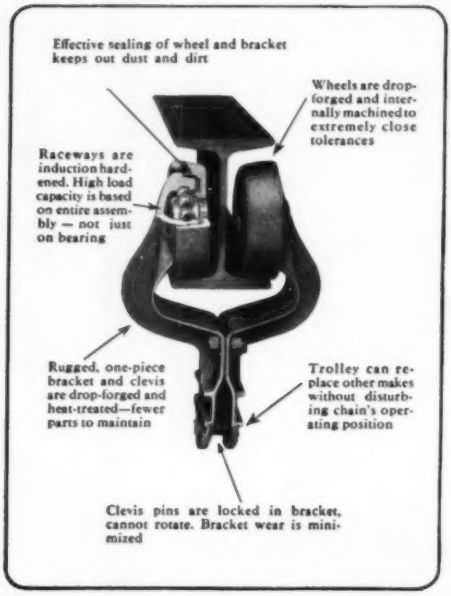
BREEZE

41 South Sixth St., Newark 7, N. J.

When you buy TROLLEY CONVEYORS...

LINK-BELT GIVES YOU BOTH!

Superior components → plus engineering ingenuity


Effective sealing of wheel and bracket keeps out dust and dirt
Wheels are drop-forged and internally machined to extremely close tolerances
Raceways are induction hardened. High load capacity is based on entire assembly — not just on bearing
Rugged, one-piece bracket and clevis are drop-forged and heat-treated—fewer parts to maintain
Trolley can replace other makes without disturbing chain's operating position
Clevis pins are locked in bracket, cannot rotate. Bracket wear is minimized

These heavy shells have ridden through a paint spray booth and are now drying on a Link-Belt Trolley Conveyor.

This Link-Belt Overhead Trolley Conveyor conveniently delivers 90-mm. shells along their finish-turn production line.

Shells travel in large quantities over long distances upon this Truck-Tow adaptation of an overhead trolley conveyor.

Travel up, down and around at synchronized speeds. Straight-line production regardless of physical layout. Saving of floor space. Release of manpower for productive jobs.

You get all these outstanding production advantages with any well-engineered overhead trolley conveyor. But you get more—much more—when you specify Link-Belt.

Not only does Link-Belt make the most popular, the most advanced trolley on the market—you also tap industry's greatest source of materials handling and power transmission experience.

Put quality manufacture plus engineering ingenuity to work for you. Our specialists will work with you and your consultants . . . help you set up smooth, steady, straight-line production in your plant.

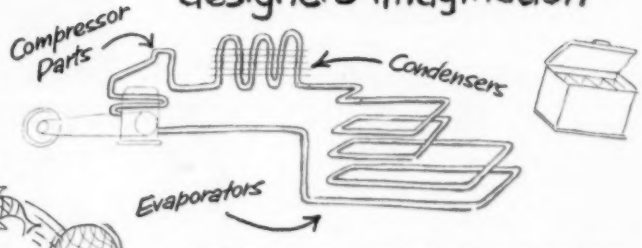
LINK-BELT

OVERHEAD TROLLEY CONVEYORS

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 12,345-A

Bundyweld "Doodles"

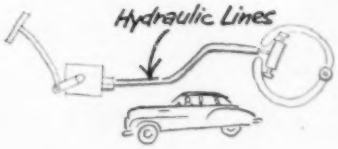
to jog a designer's imagination



Working out a new part design? Then why not let Bundyweld Tubing and Bundy engineering skills help you get better-functioning parts, faster fabrication, lowered costs?

Bundyweld performance qualities make it practical for a wide choice of applications. And, with their tested experience in designing and fabricating tubing parts, Bundy engineers can often point out ways to save you time, material, money. Write for a catalog today.

Bundy Tubing Company, Detroit 14, Michigan



Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

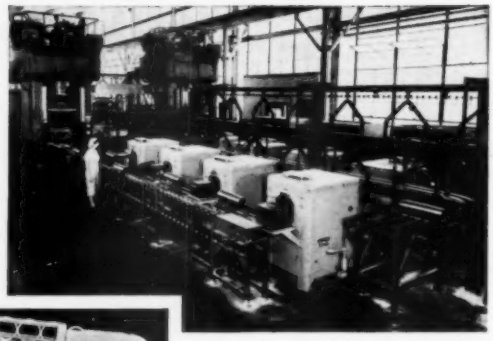
Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: Cambridge, 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • **Chattanooga 2, Tenn.:** Poirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • **Chicago 32, Ill.:** Lapham Hickey Co., 3333 W. 47th Place • **Elizabeth, New Jersey:** A. B. Murray Co., Inc., Post Office Box 476 • **Philadelphia 3, Penn.:** Rutan & Co., 1717 Sansom St. • **San Francisco 10, Calif.:** Pacific Metals Co., Ltd., 3100 19th St. • **Seattle 4, Wash.:** Eagle Metals Co., 4755 First Ave. South **Toronto, Ontario, Canada:** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

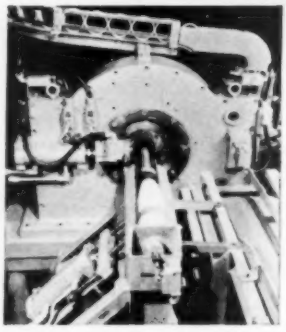
Ordnance Machinery by W. F. & JOHN BARNES

Here are only a few of the pieces of equipment built by W. F. and John Barnes for ordnance. In addition to many other individual pieces we have designed and built an entire plant for the automatic production of 155 mm high explosive shells. Other projects of similar magnitude are now in progress. We will be glad to work with you on any machining or processing problems pertaining to ordnance.



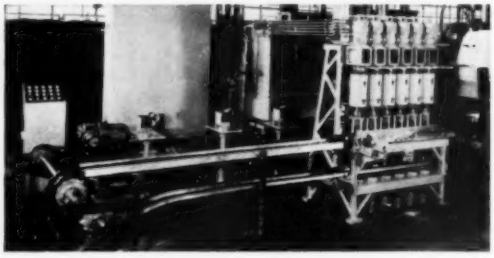
Shell Banding Machinery

Banding equipment is available for a wide variety of shell sizes. The photograph illustrates a 105 M/M shell ejected from the banding head and ready to be automatically transferred to a take-away conveyor. The automatic features and gentle handling methods of the Barnes Banding Machine has permitted successful banding of live ammunition in renovation programs. Notching heads, band resizers, band gaging units, band deburring equipment and conveyors have been developed as accessories to insure correctly banded shells. New shells can be banded at rates up to 300 shells per hour. The machines are also capable of banding shells where specifications call for a minimum content of metal in the band.



Special Conveyors

Special conveyors of all types have been designed for various processing arrangements. The illustration above represents but one example. Note the three different types of conveyors. In addition, we design and build all types of chip conveyors.



Electrical Circuits and Controls

Complete electrical circuits and controls have been designed by W. F. and John Barnes for a wide variety of installations. Shown to the right is the control desk. The desk has switches and pushbuttons for manual operation in regular or special sequence when desired. Manual switches also permit sectionalizing the machines so that only certain parts will work if desired. Lamps on the vertical face of the desk burn bright or dim in sequence to keep the attendant informed of the status of the machines functions and to give notice of any misoperation.

Cavity Facing Machinery

Other developments for ordnance work include machines for facing the explosive shell charge. This equipment can be furnished to accommodate shells from the 57 M/M to the 8 inch including 2.36, 3.5, 4.5 rockets, and the 4.2 mortar. Complete hydraulic operations, an absence of electrical controls and motors within the barricaded cubicle and full safety interlocks have eliminated the need for an operator inside the hazardous area. Signal lamps are included to inform the operator of the machine's performance. The machine shown was designed for the 3.5 rocket. The Barnes transfer fixtures which carry groups of six rockets through the facing operation are used throughout the load line for other operations.

Free Additional Literature

is available on all Barnes Ordnance equipment. Since it is impossible to give the complete scope of operation in this restricted space, we invite you to write for the complete Barnes Ordnance book. Ask for bulletins 0-952.

W. F. and JOHN BARNES

PROCESS EQUIPMENT DIVISION 320 SOUTH WATER STREET, ROCKFORD, ILLINOIS

Call **GLIDDEN** *First!*

SPECIFICATION FINISHES

★Immediate quotations on practically all Federal, Army, Navy and Air Force Specification Finishes.

★Prompt dependable help with *any* problem involving finishes or their application.

★Nine strategically-located plants throughout the United States and Canada to provide you with nearby source of finishes custom-tailored to meet your requirements.

Write, wire or phone

THE GLIDDEN COMPANY

Dept. R-952 • 1101 Madison Ave. • Cleveland 2, Ohio

- COMPOUNDS
- DOPES
- ENAMELS
- INSULATING FINISHES
- LACQUERS
- PAINTS
- PRIMERS, PAINT
- SEALERS
- THINNERS
- VARNISHES

QUALITY Glidden PRODUCTS

This Trade Mark

·HECO·

ON ROCKETS • SHELLS • FUZES

and other ammunition metal components assures the armed forces of highest quality, delivery as promised and fair price.

HECO RESEARCH CENTER—

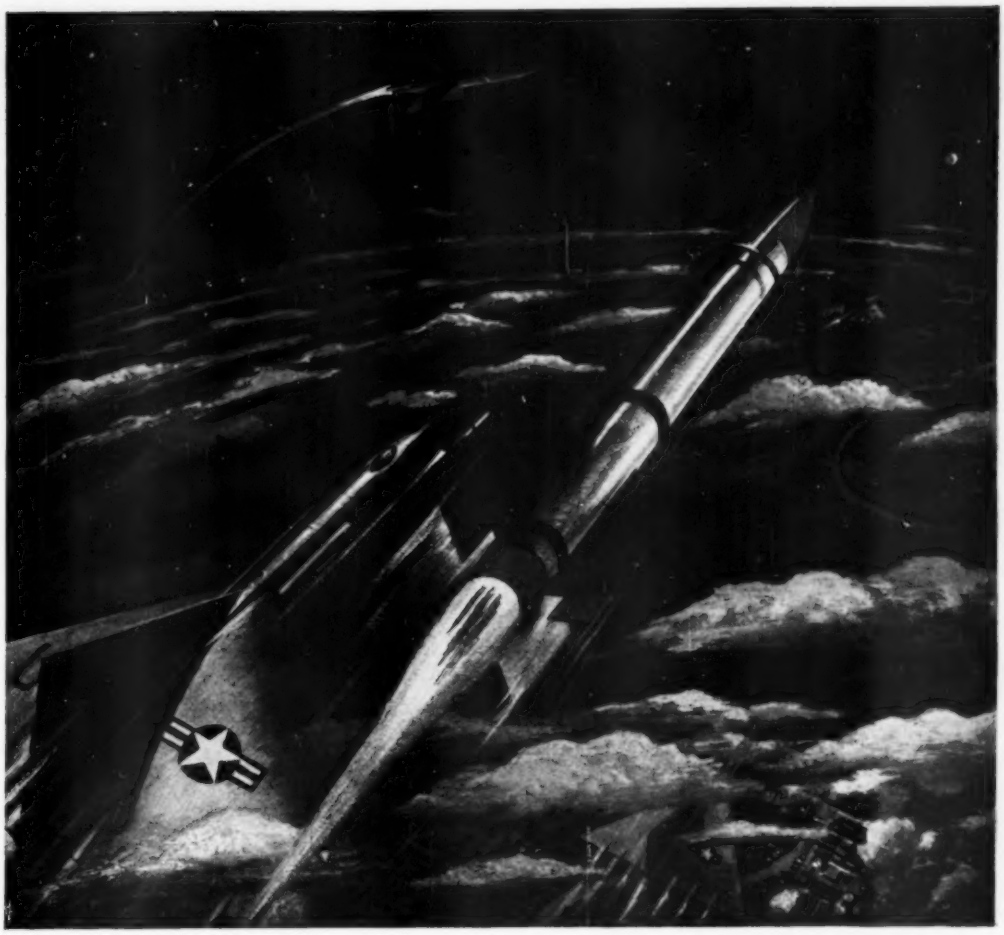
This new experimental and testing laboratory is located in South Denver, apart from the main plant.

Its alert staff and modern equipment will enable the company to broaden and increase its activity in ordnance research and development.

HECKETHORN MANUFACTURING AND SUPPLY COMPANY

Littleton, Colorado

Contractors to the United States Armed Forces for Rockets, Shells, Fuzes, Research and Development



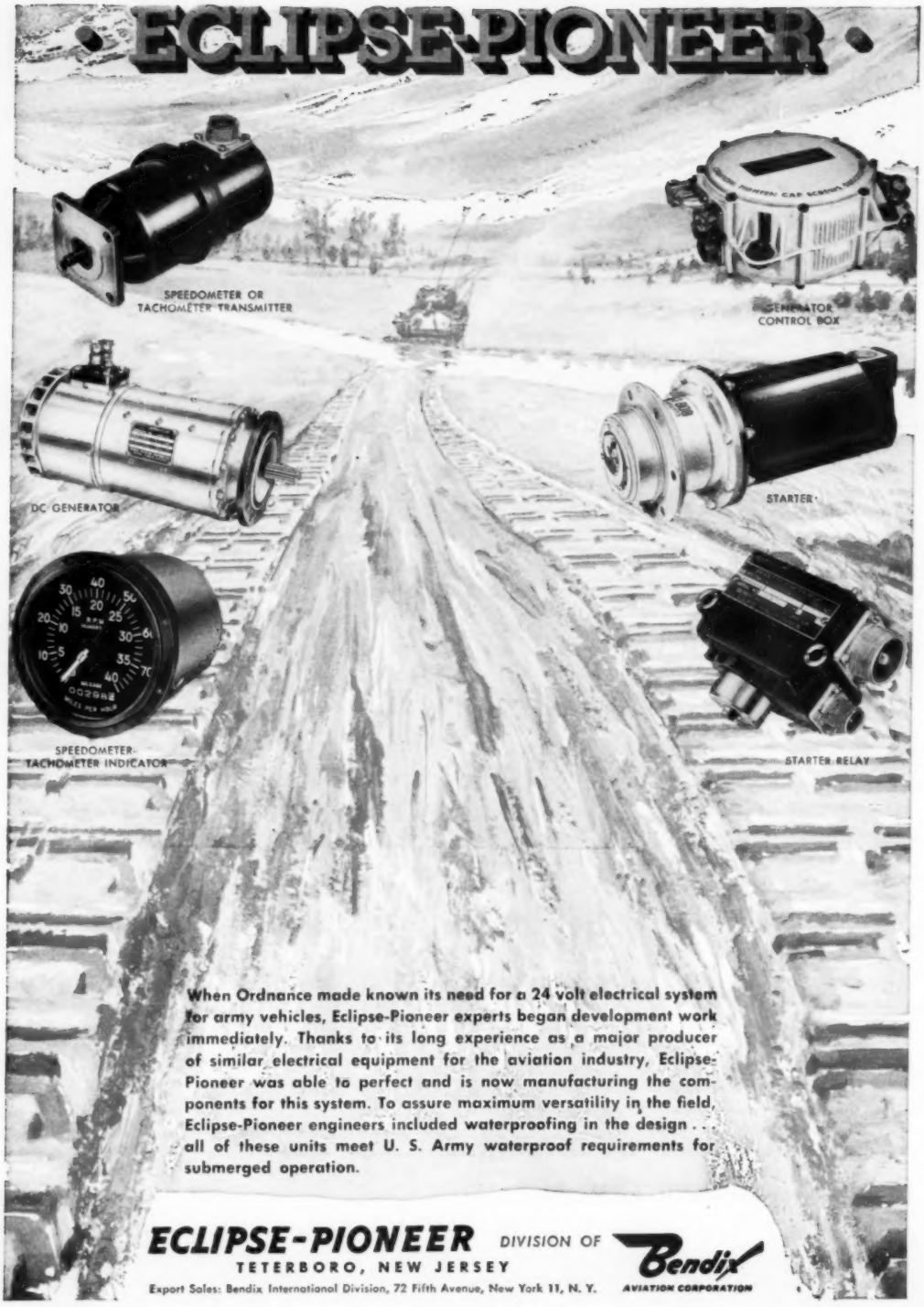
Missile with a "one track mind" ...Bomber Defense

Defensive guided missiles launched from supersonic aircraft will depend upon electronic marvels that come as close to simulating human intelligence as any mechanism ever devised. Important functions of these "weapons of the future" are typical of those entrusted to systems made by Arma Corporation.

Complex electronic and electro-mechanical controls from Arma are an integral part of many of America's most advanced weapons. In basic research, design, development and manufacture, Arma Corporation has worked in close cooperation with the Armed Forces since 1918—and more recently, the Atomic Energy Commission. *Arma Corporation, Brooklyn, N. Y.; Mineola, N. Y. Subsidiary of American Bosch Corporation.*

ARMA ADVANCED ELECTRONICS FOR CONTROL

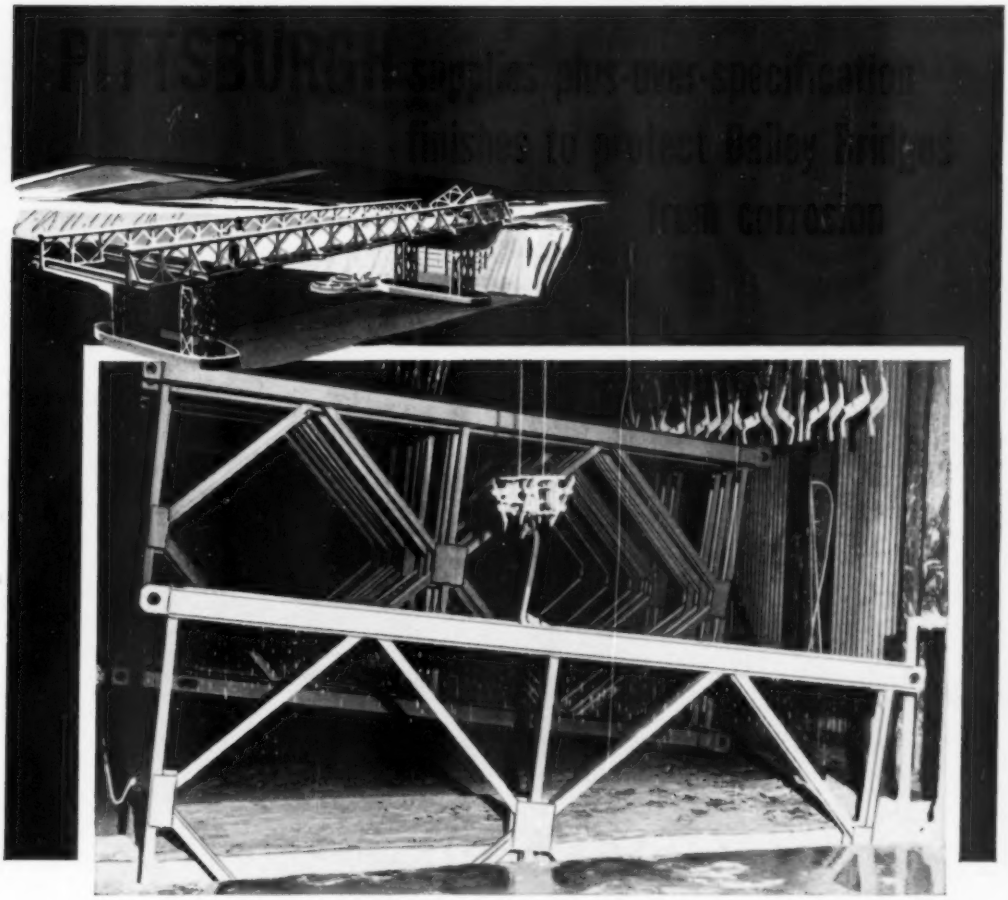
ECLIPSE-PIONEER



When Ordnance made known its need for a 24 volt electrical system for army vehicles, Eclipse-Pioneer experts began development work immediately. Thanks to its long experience as a major producer of similar electrical equipment for the aviation industry, Eclipse-Pioneer was able to perfect and is now manufacturing the components for this system. To assure maximum versatility in the field, Eclipse-Pioneer engineers included waterproofing in the design . . . all of these units meet U. S. Army waterproof requirements for submerged operation.

ECLIPSE-PIONEER DIVISION OF
TETERBORO, NEW JERSEY
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

Bendix
AVIATION CORPORATION



Prefabricated section of Bailey Bridge being lifted from dip tank in plant of Commercial Shearing and Stamping Company of Youngstown, Ohio.

PITTSBURGH'S special specification finishes are providing protection against corrosion for Bailey Bridges, the ingenious development of U. S. Army engineers that has been serving our military forces so well in Korea.

● **The Commercial Shearing and Stamping Company** of Youngstown, Ohio, was commissioned to build a number of these packaged bridges. Special finishes of extra toughness were required that would dry faster than the six hours permitted by the basic specifications.

● **Working with Army engineers** and with Commercial Shearing and Stamping technicians, Pittsburgh provided coatings that would be dry for re-coating within two hours. In addition, Pittsburgh suggested improvements in application methods for this step up in production.

● **Pittsburgh is now** also furnishing special finishes for fabricated pontoon bridges being built by Commercial Shearing and Stamping.

● **This is just one more example** of Pittsburgh's ability to provide answers to industrial finishing problems of all kinds. Pittsburgh is in position to assist manufacturers in obtaining information on specifications for finishes. Its technical men can make formula adjustments to meet production requirements and still remain within specification limits. Its service staff can aid in improving application processes.

● **This broad experience** may be helpful in solving *your* finishing problems. Write, wire or phone the Pittsburgh Paint plant nearest you. We'll be glad to have one of our engineers discuss your needs with you, without cost or obligation. Such a call may save you both time and money.

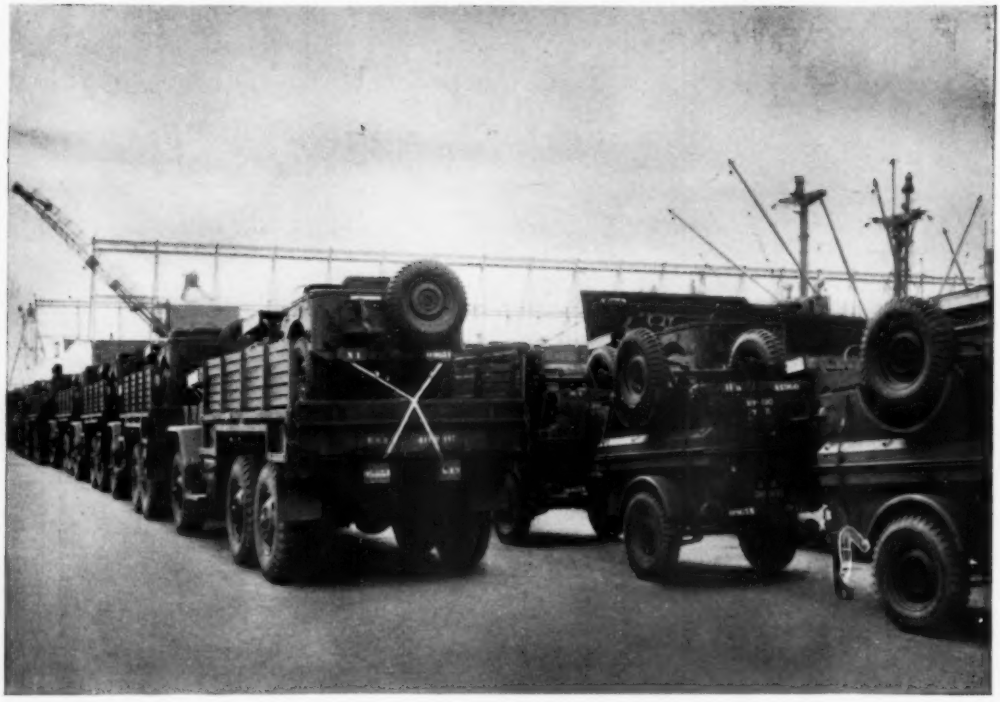
• • •

PITTSBURGH PLATE GLASS CO., Industrial Paint Div., Pittsburgh, Pa. Factories: Milwaukee, Wis.; Newark, N. J.; Springdale, Pa.; Adanta, Ga.; Houston, Texas; Los Angeles, Calif.; Portland, Ore. Ditzler Color Div., Detroit, Michigan. The Thresher Paint & Varnish Co., Dayton, Ohio. Forbes Finishes Division, Cleveland, Ohio. M. B. Suydam Div., Pittsburgh, Pa.

PITTSBURGH PAINTS

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY



NORFOLK, VA.: LONG ROWS OF MILITARY VEHICLES BOUND FOR EUROPE STAND AT THE HAMPTON ROADS PORT OF EMBARKATION WAITING TO BE LOADED ONTO SHIPS. *(Acme photo)*

...*because* Timken-Detroit is...*and was*...Prepared!

Preparedness pays! That's a fact many of us sometimes forget! *Not so* Timken-Detroit! For over 35 years a major portion of Timken-Detroit's engineering and research program has been devoted to planning, building and testing new and improved military vehicles.

Many outstanding Timken-Detroit achievements have resulted from this program—such as front-driving axles and all-gear-drive type transfer cases. Even more important is the fact that parts standardization and interchangeability within each truck class has been carried to the highest degree yet achieved.

Today, thanks in large part to Timken-Detroit's thirty-five-year program—carried on in cooperation with Armed Forces Personnel—our military forces both at home and abroad are making full use of the most advanced motorized military vehicles ever built!

TIMKEN *Detroit* **AXLES**

A PRODUCT OF THE TIMKEN-DETROIT AXLE COMPANY

DETROIT 32, MICHIGAN

Accepted T D A *Standard*

TRADE MARK REGISTERED

PLANTS AT: DETROIT AND JACKSON, MICH. • OSHKOSH, WIS. • UTICA, N. Y. • ASHTABULA, KENTON AND NEWARK, OHIO • NEW CASTLE, PA.

On the double...

Production lines have to move quickly..."on the double"...these days. And they have to be "double" in another way, too...they must produce for *both* industry and defense needs.

American Locomotive, for example, in a completely separate operation, makes the Army's mighty new medium tank. In other plants, top priority equipment for the Army, Navy, Air Force and Atomic Energy Commission is produced.

Simultaneously, Alco production lines are turning out modern diesel-electric locomotives and basic equipment essential to the rail, oil, power and chemical industries.

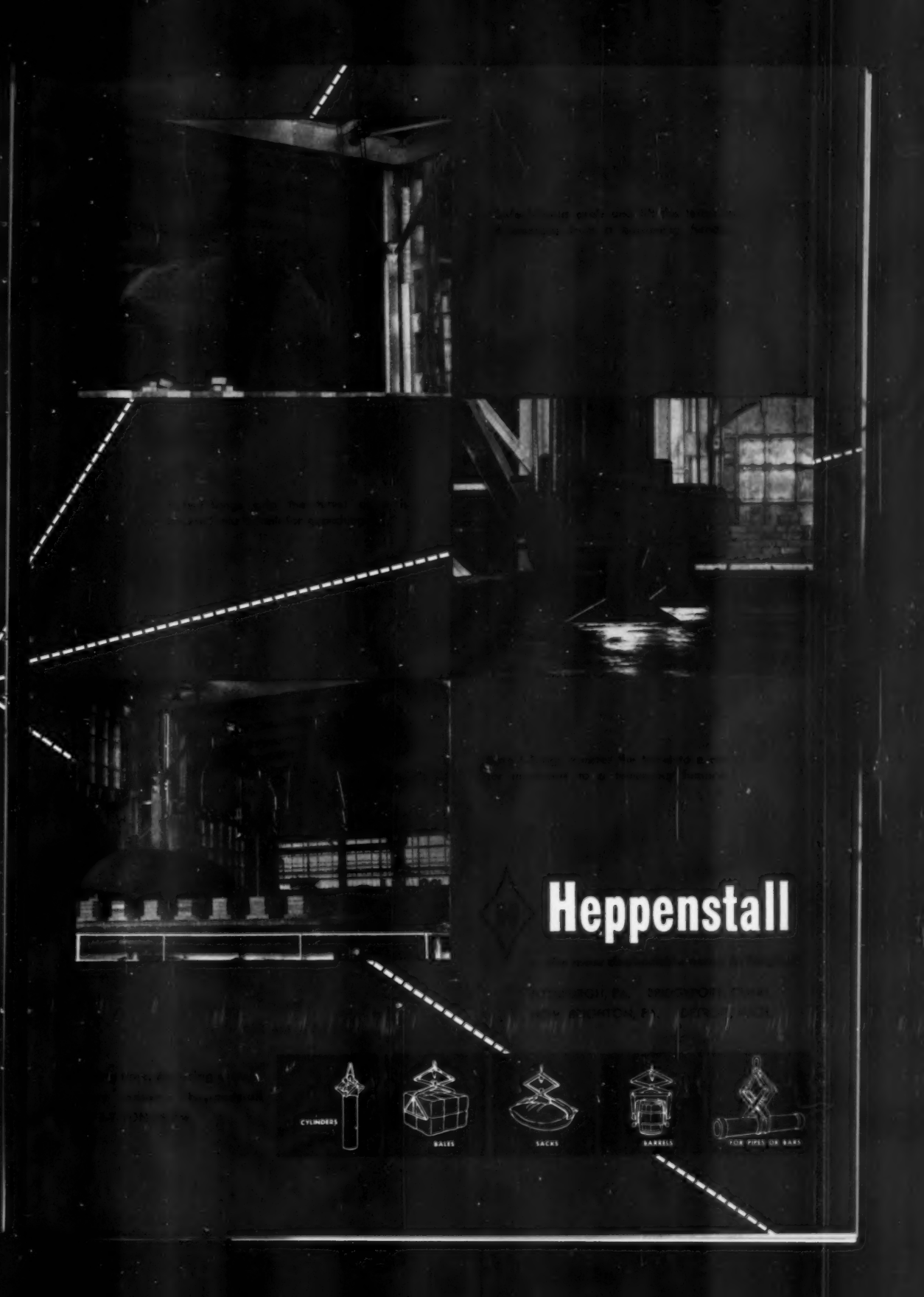
This "on-the-double" production is a necessity if we are to keep America's growing strength on a secure foundation.

AMERICAN LOCOMOTIVE COMPANY

producing both industrial and defense products

Quick, safe handling of a **12 ton** *turret*

Safe-T-Tongs


Heppenstall
CYLINDERS
BALES
SACKS
BARRELS
FOR PIPES OR BARS

Why.....

magneto ignition?

BENDIX Magneto Ignition has traditionally been used on engines in critical installations where "keeping the engine going" is a "must."

BENDIX Magneto Ignition, an independent self-sufficient system, places no demands on a normally loaded electrical supply.

BENDIX Magneto Ignition produces a hot spark at all speeds.

BENDIX Magneto Ignition provides for ease of service due to its compactness and simplicity.

BENDIX Magneto Ignition minimizes fire hazard with elimination of supply leads.

BENDIX Magneto Ignition inherently provides superior radio-shielding and water-proofing.

BENDIX Magneto Ignition contact points and distributor electrodes have longer life because of inherent current reversal.

BENDIX Magneto Ignition has proven its efficiency, reliability and safety by its use on piston engine aircraft where no compromise is accepted.

Ordnance standards for material and equipment are necessarily the highest. Vehicles of all types must operate at maximum efficiency under every conceivable condition. Servicing must be accomplished simply and speedily, and long, dependable life for every component is a prime requisite. It is evident that magneto ignition provides the superior qualities that are required for ordnance vehicles.

Bendix

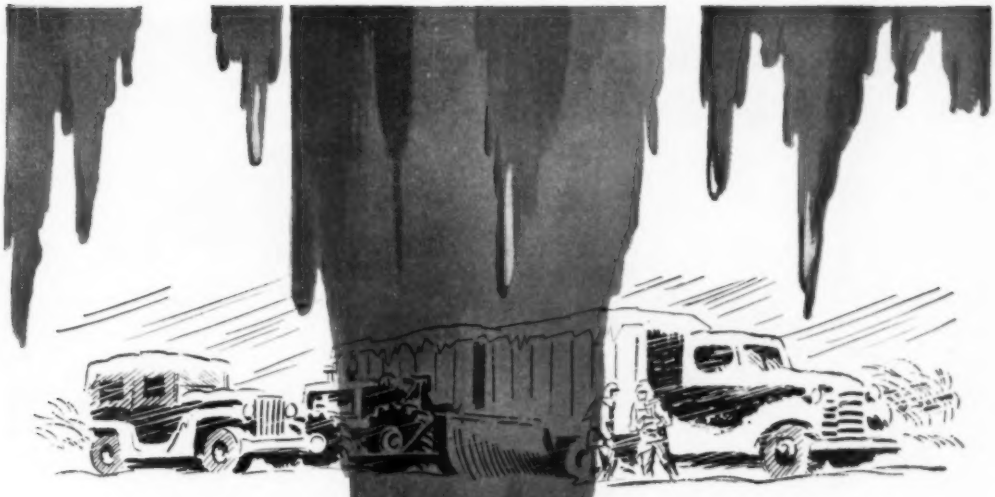
SCINTILLA MAGNETO DIVISION OF SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan

Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California



When they gotta go ... at 65° below!

To be *sure* your equipment and vehicles will "go" in sub-arctic service ... be sure you get the *right type* of heating system. Come to the people who have successfully developed and produced *BOTH AIR AND COOLANT-TYPE ENGINE HEATERS.*

Perfection engineers are ready to give you the full benefit of our 15 uninterrupted years of designing and producing winterization systems for all types and sizes of vehicles and equipment.

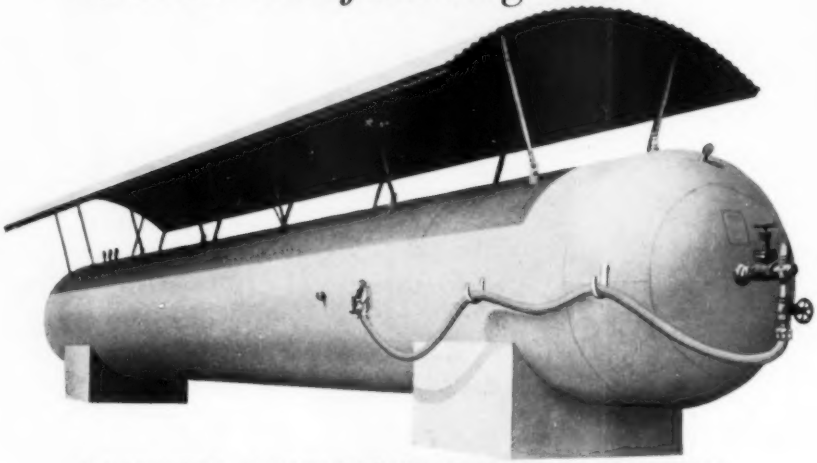
Over 100,000 Perfection systems are in service today. Ask for our Winterization Data File. Perfection Stove Company, 7341-B Platt Avenue, Cleveland 4, Ohio.

HERE'S WHAT WE DO

1. *Develop the winterization system.*
2. *Apply it to the vehicle or equipment.*
3. *Test it to government specifications in our Cold Rooms.*
4. *Prove that it meets those specifications.*
5. *Guarantee that the equipment will go at 65 below!*
6. *Make the drawings for your production, or produce the systems for you.*

Perfection

Another Example of Beaird Manufacturing Skill



PACKAGED ANHYDROUS AMMONIA STATION

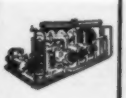
The introduction of anhydrous ammonia as a fertilizer has called for an entirely new line of equipment for storing and handling this nitrogen-rich liquefied gas. Beaird has worked closely with the ammonia industry in developing the necessary special equipment to meet this need. Latest addition to the Beaird line is the packaged anhydrous ammonia dispensing station, designed and patented by Beaird. Several hundred of these stations are already in use in agricultural areas of the nation.

THIRTY-FOUR YEARS' EXPERIENCE in manufacturing a wide variety of products have made Beaird unusually well equipped to handle large production orders of ordnance materials.

Central location near Southwest ports
Ample supply of Skilled labor
Modern manufacturing facilities
Experienced engineering staff
Trained inspection department
Strong financial position

SINCE 1918
BEAIRD
SHREVEPORT
MACHINING FABRICATING STEEL WAREHOUSE

THE J. B. BEAIRD COMPANY, INC. SHREVEPORT, LOUISIANA


PACKAGED COMPRESSOR PLANTS

LP GAS SYSTEMS

CAST STEEL FITTINGS

ANHYDROUS AMMONIA EQUIPMENT

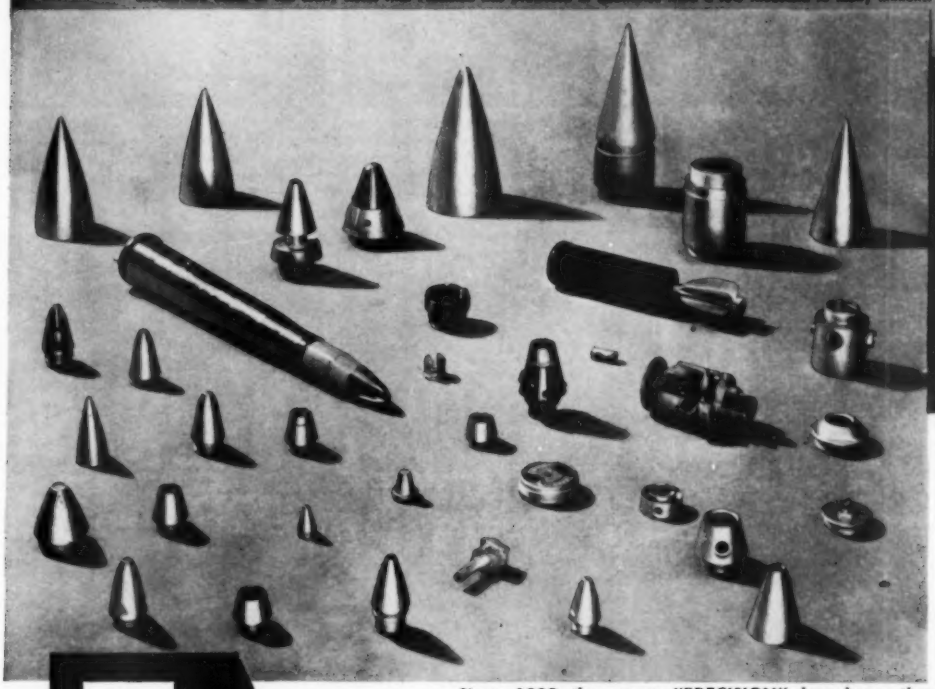
PRESSURE BULK STORAGE

In Defense, War or Peace--

You Can Depend on PRECISION DIE CASTINGS!

In defense and civil production, there is increasing need for lighter, stronger, accurate products and components at lower cost. The answer is *Precision Die Castings*—durable, dependable, designed to solve your production problems by the foremost engineering skill in the die casting industry.

We can offer you experience and production know-how in producing hundreds of different items essential to defense. Shown are some of the many items that Precision has produced in quantities from a few thousand to many millions.



Since 1909 the name "PRECISION" has been the symbol of highest quality in the die casting industry.

PRECISION CASTINGS CO., Inc.

212 Walnut St., Fayetteville, N. Y.

Syracuse, N. Y. · Cleveland, O. · Kalamazoo, Mich. · Chicago, Ill.

British Affiliation — Wolverhampton Die Casting Co., Wolverhampton, England

MIL-P-116A, Military Specification for Methods of Preservation dated March 25, 1952, method 1A-2 "Container, Overwrap, Dip-coat Sealed."

READ AND SAVE THIS ISSUE FOR FUTURE REFERENCE

MILITARY PACKAGING SIMPLIFIED 4 of a series

1. Parts cleaned and proper preservative applied, ready for greaseproof aluminum foil wrap (JAN-B-148)*. Note how aluminum foil can be "doughnut" wrapped, thus using less material.

**Obtain permission for Air Force use*

2. Wrapped rings inserted in manufacturer's carton ready for further packaging. This method is very acceptable, especially when correctly fitted cartons or containers are readily available. Secure label to carton.

3. Application of Grade C (JAN-B-121) overwrap. Be sure to use enough material to allow ample overlaps and avoid puncture of material by corners of carton.

4. Completed Grade C overwrap. Note the use of the "drugstore" or "locked seam" fold which adds to the waterproofness of this package.

5. Fold all seams and folds of Grade C overwrap down firmly by means of a tool. An adhesive known as Grade C sealer should also be used.

6. Completed package after dipcoating. Be sure to dip from either end and overlap by at least one inch. Affix label to dip-coat and overwrap with kraft or glassine paper to prevent blocking. If kraft is used, attach an additional label.

Note: *MIL-P-116A was approved by the Departments of Army, Navy, and Air Force for use of the procurement services of the respective Departments.*

FOIL PACKAGING FOR CIVILIAN MARKETS

Foil is available again for non-military uses. This should be good news to many manufacturers. Because...industrial spare parts need protection too. And the "eye appeal" of brilliant aluminum foil is an asset to any product. Put foil to work for you as a wrap, a bag, a carton, a container or label. Let aluminum foil do double duty...giving your product "eye appeal" as well as protection... and watch sales grow.

SEE REYNOLDS TRAVELING DEMONSTRATION OF MILITARY PACKAGING!

Government-specified methods of foil and laminated-foil packaging demonstrated with actual military products and parts. *Write for Coach Itinerary!* For expert help on any packaging problem, call the nearest Reynolds Sales Office and ask for the "Packaging Man." Or write direct to Reynolds Metals Company, General Sales Office, Louisville 1, Kentucky.

REYNOLDS ALUMINUM

THE INDUSTRY'S FINEST POWER BRAKING SYSTEMS

Star Performers

IN THEIR FIELDS!

In any field of endeavor, consistently good performance is the only road to success. And that is precisely why Bendix® Hydrovac® and Bendix Air-Pak are the recognized leaders in the power braking field. More than two and a half million installations and billions of miles of service have proven Hydrovac the unchallenged leader in the field of vacuum-hydraulic braking.

Air-Pak, similar in design and principle to the Hydrovac, has by its outstanding performance established itself as the industry's foremost air-hydraulic power brake unit.

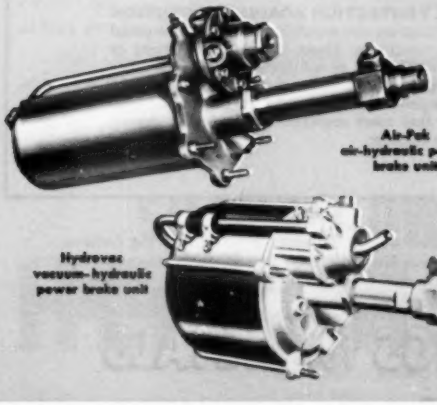
Products of twenty-five years of practical braking experience, these outstanding power braking systems offer faster, more positive and better controlled braking. And in both the vacuum and air actuated units, brakes can be applied instantly by foot power alone—a constant safety factor of importance.

Regardless of size of vehicle or whether the preference is for vacuum or air actuated brake, for consistently good performance, it pays to specify Bendix Hydrovac or Bendix Air-Pak—the industry's Finest Power Braking Systems. ®REG. U. S. PAT. OFF.

BENDIX • PRODUCTS DIVISION • SOUTH BEND

Export Sales: Bendix International Division, 72 Fifth Ave., New York 11, N. Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

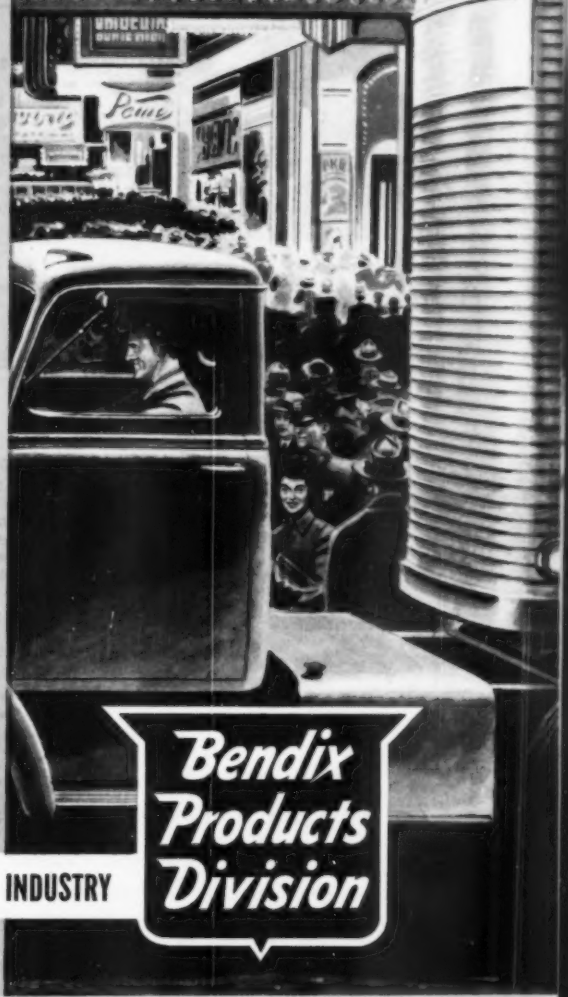
AVIATION CORPORATION



Air-Pak air-hydraulic power brake unit

Hydrovac vacuum-hydraulic power brake unit

FEATURING ★ AIR-PAK HYDROVAC POWER BRAKING



BRAKING HEADQUARTERS for the AUTOMOTIVE INDUSTRY

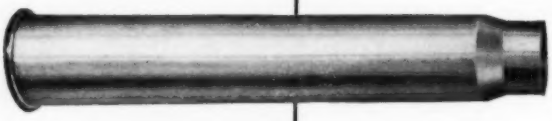
Bendix Products Division

How to make shorter work of finishing* problems

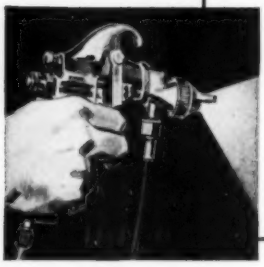
** in plating * in "painting" * in chromate-treating*

You take effective action on metal finishing problems when you contact United Chromium... a source that is already providing many companies with the help they need on ordnance finishing. Nearly 25 years' experience, together with a line of outstanding metal and organic finishes, stand ready to help you too if you have to apply unfamiliar finishes... or want to improve present finishing operations. Here are just three examples of how working with "Unichrome" Coatings for Metals cuts expenses and satisfies specifications in shorter time and with less trouble.

INCREASED OUTPUT OF HARD CHROMIUM PLATING Increases of from 20% to 80% in plating speed have been obtained by plating in the Unichrome *Self-Regulating High-Speed* Chromium Bath instead of the ordinary bath. Recent records reveal that piston ring plating took 3½ hours instead of 5. Aircraft brake discs were done in 40 minutes instead of the former 65 minutes. The bath also minimizes control problems because of its self regulation. This feature saves additional time, minimizes rejects.



MASS PRODUCTION OF A CHROMATE FINISH ON ZINC The Anozinc* process for zinc plate uses current to form a black, yellow or clear chromate finish with superior corrosion resistance and extra toughness. It uses conventional plating equipment, permitting fast, continuous processing of such parts as steel shell casings, die castings, propeller blades. Parts can be handled while still wet.



APPLY DURABLE PROTECTION AGAINST CORROSION Ucilon* Protective Coatings add durability to products exposed to tough, corrosive conditions. These include intermittent or continuous contact with fumes or solutions — with acids, alkalies, salts, alcohols, moisture, oils, greases, chemical compounds, detergents and other products. Also available: Unichrome Lacquers and Enamels that meet requirements for quick-drying, lustreless protective coatings.

More information on these and many other problem-solving finishes are as close as the nearest United Chromium office. Write or phone us on *your* needs in finishes for metals. **Trade Mark*

UNICHROME Trade Mark **COATINGS for METALS**

UNITED CHROMIUM, INCORPORATED 100 East 42nd St., New York 17, N. Y.

Waterbury 20, Conn. • Detroit 20, Mich. • Chicago 4, Ill. • Los Angeles 13, Calif. In Canada: United Chromium Limited, Toronto, Ont.

Solve the need for

SPOT HEAT

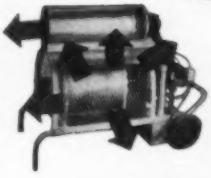
INSTANTLY!

Whenever, wherever you must provide temporary, emergency heat, you can depend on Silent Glow's Model RF to do an effective, economical job to insure more comfortable working conditions in winter weather . . . de-ice equipment . . . preheat areas.

Easy to transport, just wheel the unit where you want it . . . easy to operate, just flick the switch (no torch, match or open flame required). In five minutes you'll have all the heat you need. Unit delivers 168,000 BTU per hour.

SAFE . . . all moving parts and heated surfaces fully protected . . . unit cannot be tipped over accidentally . . . fire goes out immediately when switch is snapped off or power is shut off. CLEAN . . . burns without soot, smoke or fumes . . . no carbon monoxide or unburned hydrocarbons. ECONOMICAL . . . low original cost, low operating cost . . . 100% utilization of fuel, uses No. 2 fuel oil.

Mail coupon today for complete information about the Model RF and other Silent Glow Portable Heaters.



Two kinds of heat . . . radiant . . . forced air by means of auxiliary fan.

More than 10,000 Silent Glow Heaters on duty in the United States and abroad . . . approximately 100 functioning perfectly in Alaska's extreme temperatures.

Use the MODEL RF to —

- Provide more comfortable working conditions in warehouses, machine shops, on loading platforms and docks . . . for outdoor repair crews, etc.
- De-ice vehicles, machinery, ship decks, etc.
- Pre-heat freight cars, engines, etc.
- Thaw frozen transmissions, wheels, gears, etc.
- And for a wide range of other applications where it is important to provide spot heat.

SILENT GLOW HEATERS PORTABLE

Manufactured by pioneers in the oil burner field.

To: THE SILENT GLOW OIL BURNER CORP.

851 Windsor Street, Hartford 5, Connecticut
1500 So. Western Ave., Chicago 8, Illinois

Send us the complete story about Silent Glow Heaters.

Name _____

Company _____

Street _____

City _____ State _____

Filling the Breach

at 250 Rounds Per Hour

W-S SEMI-AUTOMATIC SHELL BANDING PRESS

For Conventional Bands or Powdered Metals

Here's a machine that's setting new daily production records right at the shell banding station . . . with rates up to *250 per hour* on 90, 105, 120, and 155 MM ordnance.

With exception of the loading operation, control is entirely automatic. Pressing the "cycle-start" button causes twenty-four synchronized rams to move in radially upon the shell, exert preset pressure, and dwell for an automatically timed period. Another push-button operates the automatic air-ejector.

Where unit work pieces are large and heavy, this kind of mechanized operation and handling pays off in increased man-hour productivity even over extended work periods. The proven design provides the maximum in trouble-free availability and low maintenance . . . You get less rejects. Capacity 500 Tons . . . overall height 3 ft. . . . floor space required 8' 6" x 6' 0".

Write for complete details of this latest revolutionary development in our national preparedness machine.

WATSON-STILLMAN
ESTABLISHED 1848

HYDRAULIC MACHINERY DIVISION

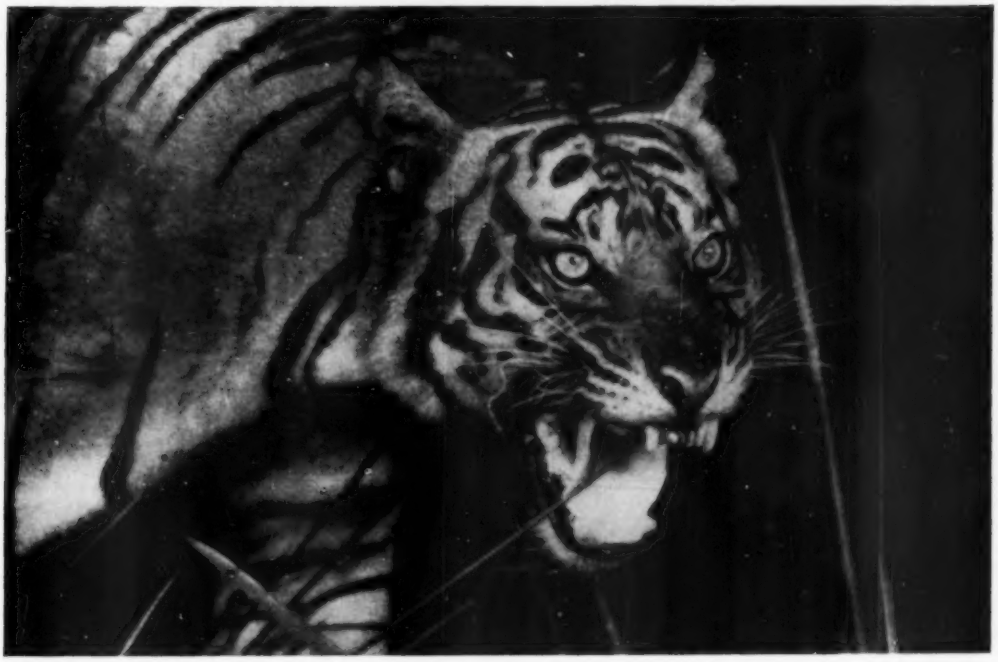
Factory and Main Office:
164 Aldene Rd., Roselle, N. J.

W-S Completeline

Branch Off.: 228 N. LaSalle, Chicago Ill. • Manufactured in Canada by Canadian-Vickers, Ltd., Montreal

HYDRAULICS . . . THE SHORTEST DISTANCE FROM PRODUCTION TO PROFIT

You can't stop a tiger with a water pistol



You can't stop corrosion with ordinary paints . . .

it takes BITUMASTIC COATINGS!

CORROSION can't be stopped by ordinary paints or conventional protective coatings. They can't protect surfaces against the ravages of rust for any appreciable length of time.

But Bitumastic Coatings can!

FIRST—Unlike maintenance paints, Bitumastic® Protective Coatings are specially formulated from a base* of coal-tar pitch that is, for all practical purposes, impervious to water. When you keep moisture away from an exposed surface, you *stop* corrosion.

SECOND—Bitumastic Coatings provide an extra-tough, extra-thick barrier against corrosive elements—a barrier that is impenetrable. These coatings provide up to 8 times the film thickness of conventional paint coatings.

THIRD—Bitumastic Coatings stop corrosion caused by moisture—acid fumes—alkaline fumes—corrosive soil—salt air—heat.

There are 6 Koppers Coatings—formulated to control corrosion of metal and deterioration of concrete. Use the coupon for full information.

**Hi-Heat Gray contains a metallic base.*

SEND FOR SET OF FREE BOOKLETS!

Koppers Company, Inc., Tar Products Division
Dept. 970-T, Pittsburgh 19, Pa.
Please send me, without charge or obligation, your booklets on corrosion prevention.

Name.....

Address.....

City.....Zone.....State.....

KOPPERS BITUMASTIC PROTECTIVE COATINGS

SOLD THROUGH INDUSTRIAL DISTRIBUTORS

KOPPERS COMPANY, INC., Tar Products Division, Dept. 970-T, Pittsburgh 19, Pa.

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

an ACCO product

Stainless Steel WELDING ELECTRODES

AC or DC made by PAGE for Armor Welding

the BEST for any weld . . . on all types of stainless steel

Retain Strength

• The great strength of stainless steel—used widely in all manufacturing including military work—is limited by the quality of welds which seal the joints. So you must choose electrodes with care to retain full strength.

Page offers you a full line of stainless steel armor welding electrodes, AC or DC, made to present Ordnance specifications. Arc is stable under all conditions. The metal flows smoothly. Slag is clean and easily removed. The coating resists cracking down to very short stubs. Available in 10-lb. lined, hermetically sealed, reclosable cans.

Be Sure . . . Specify

PAGE STAINLESS STEEL ELECTRODES

ACCO

PAGE STEEL AND WIRE DIVISION
AMERICAN CHAIN & CABLE

Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Portland, San Francisco, Bridgeport, Conn.

PAGE Welding Electrodes

ATOMIC ENERGY

CONSTRUCTION CONTRACTS

Award of construction contracts for expansion of the U. S. Atomic Energy Commission's gaseous-diffusion plants at Oak Ridge, Tenn., and Paducah, Ky., was announced recently.

A $464,000,000 addition at Oak Ridge will be built by the Maxon Construction Company of Dayton, Ohio. At Paducah, the prime contract on a $459,000,000 addition to the uranium-235 separation plant now under construction has been awarded to F. H. McGraw & Company, of Hartford, Conn. McGraw is also contractor for the production facilities now being built at Paducah. A substantial part of the work at both sites will be done under fixed-price subcontracts.

The following architect-engineer firms already are at work planning and designing the new facilities: Giffels & Vallet, Inc., Detroit—design and supervision of plant construction; Sargent & Lundy, Inc., Chicago—design of high-voltage power-distribution systems and substation.

Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation, will operate both new plant additions.

Tight construction schedules and the urgency for increasing production facilities were important factors in selecting Maxon and McGraw both of whom have had experience in building gaseous-diffusion facilities. Their selection will assure maximum speed and efficiency in constructing the new plants.

Funds for the Oak Ridge and Paducah expansions were included in the 1953 Independent Offices Supplemental Appropriation Act signed by the President on July 14, 1952. This measure appropriated a total of $2,986,894,000 for the Commission.

ISOTRON SEPARATION

Details of one of the early isotope-separation experiments, based on a machine called the isotron separator, have been declassified by the Atomic Energy Commission as a part of its program to add to basic knowledge available to science.

The isotron isotope separator was developed at Princeton University in 1941-1942 during intensive scientific investigation of electromagnetic methods of separating uranium-235 from uranium-238. The device was given the deliberately meaningless name of "isotron" because of the wartime secrecy involved. It is a machine which may be used either to separate

with close-tolerance

ROCKRITE TUBING

In a Hamilton Standard hollow-steel aircraft propeller-blade, the core or spar provides most of the structural strength. It must also be dimensionally accurate to prevent vibration so that blades stay in balance during flight.

To achieve this vital accuracy, manufacture is started with seamless-tube high-alloy forgings, turned, bored and ground. These forgings are then compression-formed by the Rockrite process. This preserves their accuracy and results in a longer core-tube of tapered outside diameter and with a tapered wall.

If tubing accuracy is important in your ordnance production, investigate the advantages of Rockrite . . . the tubing that is sized by a distinctively different process. Write for Bulletin R2.

Cross-section of a Hamilton Standard hollow-steel propeller-blade showing the core, the shell and the synthetic rubber which fills the interior cavities.

ROCKRITE® TUBING

TR-130

TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

O&S BEARINGS
NON-METALLIC • SELF LUBRICATING
RADIAL LOAD
CORNER LOAD
AXIAL LOAD
O & S has the RIGHT ANGLE on BEARINGS
. . . for combined axial, radial and corner loads
NYLON INSERT
All Purpose Bearing . . .
AXIAL LOAD
CORNER LOAD
RADIAL LOAD
LUBRICANT IMPREGNATED FABRIC
By combining the inherent characteristics of the efficient O & S lubricant impregnated bearing material and the recently developed nylon bearing material we have found the answer to the problem of simultaneously combined radial, axial and corner loading.
If you have a problem that involves all three—write for Bulletin 133.
NeverOil
SINCE 1919
O & S BEARING CO.
303 SOUTH LIVERNOIS • DETROIT 17, MICHIGAN

isotopes or, as a mass spectrometer, for measuring masses of ions, using the "time-of-flight" principle.

The isotron project was abandoned in February 1943 because other methods of producing U-235 showed more promise. Since then the principles underlying the isotron method have been studied further. These studies have concluded that the isotron method is not a practical way of producing isotopes in the quantities needed in the classified work of the AEC.

However, the method may be valuable in other types of nuclear physics research having no connection with separating uranium isotopes. Therefore, as an aid to this type of inquiry, the Commission has authorized the declassification of the isotron isotope separator experiments and theory as described in various early project reports.

ISOTOPE DISTRIBUTION

More than 600 universities, hospitals, and research laboratories in 46 States are using isotopes produced by the U. S. Atomic Energy Commission for medical, biological, industrial, agricultural, and scientific research and medical diagnosis and treatment.

The report, "Isotopes—A Five-Year Summary of U. S. Distribution," is available to the public from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $1.00 a copy. A summary of isotope applications considered to be of significance to industry has been compiled from the 5-year summary and printed separately as document TID-5078 available at the Office of Technical Services, Department of Commerce, Washington 25, D. C., for 30 cents a copy.

The full report on isotope distribution for five years shows that more than 18,900 shipments of radioactive isotopes and 1,500 stable isotopes have been made to users in the United States and that 1,100 radioactive isotope shipments have been made to users outside the United States.

A brief summary of the growth of the isotope program and descriptions of their uses are included in the report with a list of the users and the titles of 1,400 technical reports and papers published on isotope work in the past two years.

INDUSTRIAL HYGIENE

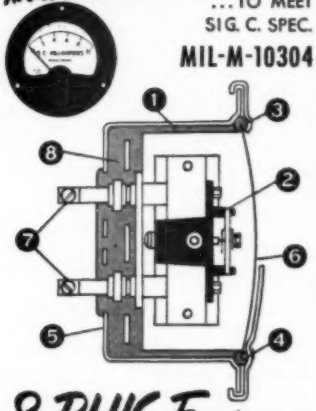
The Atomic Energy Commission has inaugurated a one-year fellowship training program for industrial hygienists, starting in the fall of 1952.

If qualified candidates can be obtained, up to four will be selected for one school year of academic training. Commenting upon this program, Dr. Shields Warren, Director of AEC's Division of Biology and Medicine, said:

Available NOW!

RUGGEDIZED METERS

...TO MEET SIG. C. SPEC. MIL-M-10304



8 PLUS Features

EXTRA "RUGGEDIZED" FEATURES

1. Meter movement shock-mounted and housed in rubber-lined case.
2. Meter movement supported by die-cast frame for greater strength and increased accuracy.
3. Observation window rubber grommeted and sealed to rubber lining of case—providing hermetical seal of high dielectric materials.
4. Non-rigid mounting of observation window with rubber grommet increases resistance to shock.
5. Each meter designed and built by SUN to highest quality and precision standards.

EXTRA INSTALLATION ADVANTAGES

6. Slight convexity of observation window reduces chance of accidental breakage during installation or shipment.
7. Terminals side-tapped and provided with tined binding screws to facilitate wiring with or without wire lugs or by pressure, soldering or both.
8. Breakage or damage in wiring is reduced through non-rigid mounting of terminals and use of flexible interior conductors.

Building rugged electric meters is not new to SUN . . For over 20 years, the automotive industry has depended on SUN as one of the largest "D'Arsonval-type" meter manufacturers—to produce rugged, tough meters that will stand up under the abuse and rough handling of portable field instruments used in automotive repair work. SUN "Ruggedized" Meters not only meet Specification MIL-M-10304 (Sig. C)—but also embody many *plus* features that make installation easier, faster and help prevent assembly or shipping damage. Complete data bulletin on SUN "Ruggedized" Meters available on request.

SUN "Ruggedized" Meters are available as D-C Volt Meters, Ammeters, Milli-ammeters and Micro-ammeters and also may be ordered as rectifier type A-C instruments.

6060-0

SUN ELECTRIC CORPORATION

6371 Avondale Avenue, Chicago 31, Illinois

the unseen member of the crew

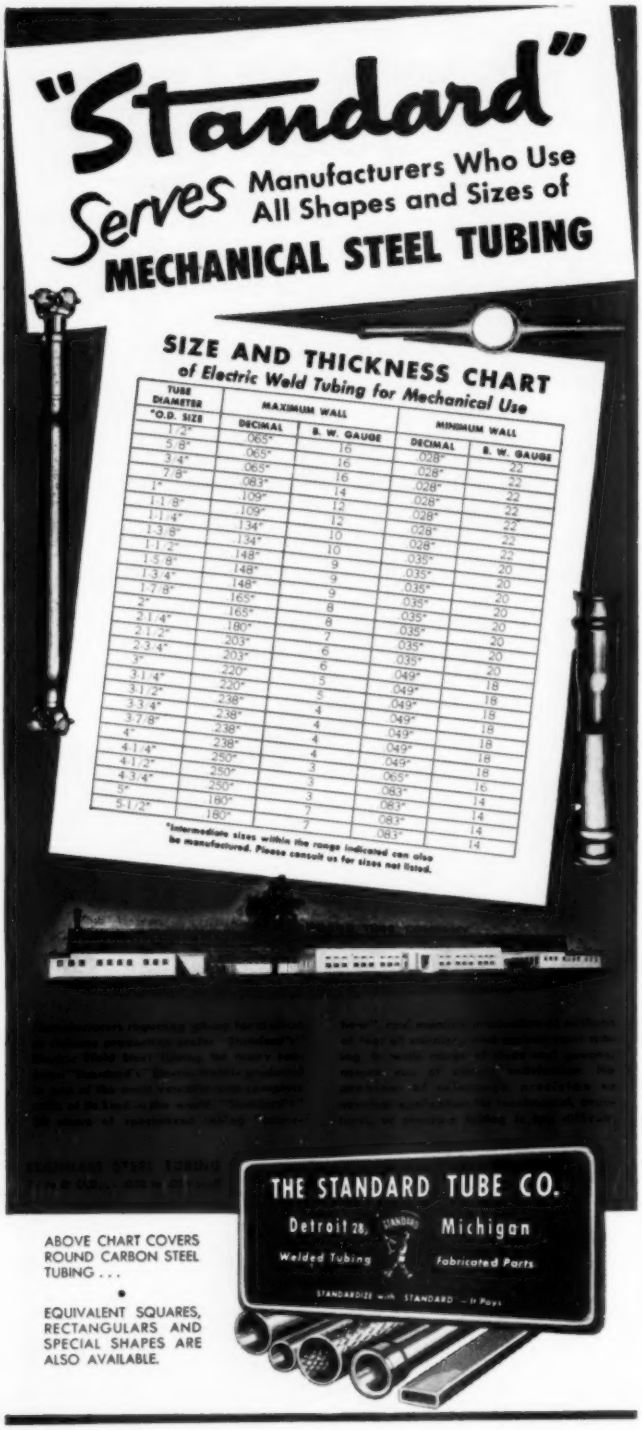
The electronic brain . . . deep in the heart of a complex fire control system . . . is adding tremendously to the Navy's striking power. Automatically figuring speed and wind velocity, the "brain" obeys a single command with deadly accuracy and lightning speed. Unfailing response, utmost dependability are guaranteed only through highest quality electronic components. Magnetic Metals Company precision made core parts and shield assemblies are specified for these applications to provide the ultimate in performance and accuracy.

MAGNETIC METALS COMPANY

Soft Iron and Alloy Cores and Shields

21ST & HAYES AVENUE · CAMDEN 1, N.J.

OFFICIAL DEPT. OF DEFENSE PHOTO


"Standard"
Serves Manufacturers Who Use All Shapes and Sizes of
MECHANICAL STEEL TUBING
SIZE AND THICKNESS CHART
of Electric Weld Tubing for Mechanical Use
TUBE DIAMETER "O.D. SIZE
MAXIMUM WALL
DECIMAL
B. W. GAUGE
MINIMUM WALL
DECIMAL
B. W. GAUGE
1/2" .065" 16 .028" 22
5/8" .065" 16 .028" 22
3/4" .065" 16 .028" 22
7/8" .083" 14 .028" 22
1" .109" 12 .028" 22
1 1/8" .109" 12 .028" 22
1 1/4" .134" 10 .028" 22
1 3/8" .134" 10 .028" 22
1 1/2" .148" 9 .035" 20
1 5/8" .148" 9 .035" 20
1 3/4" .148" 9 .035" 20
1 7/8" .165" 8 .035" 20
2" .165" 8 .035" 20
2 1/4" .180" 8 .035" 20
2 1/2" .203" 7 .035" 20
2 3/4" .203" 6 .035" 20
3" .220" 6 .035" 20
3 1/4" .220" 5 .049" 18
3 1/2" .238" 5 .049" 18
3 3/4" .238" 4 .049" 18
3 7/8" .238" 4 .049" 18
4" .238" 4 .049" 18
4 1/4" .250" 4 .049" 18
4 1/2" .250" 3 .049" 18
4 3/4" .250" 3 .065" 16
5" .250" 3 .083" 14
5 1/2" .180" 7 .083" 14
.180" 7 .083" 14
*Intermediate sizes within the range indicated can also be manufactured. Please consult us for sizes not listed.
THE STANDARD TUBE CO.
Detroit 28, Michigan
Welded Tubing
Fabricated Parts
STANDARDIZE with STANDARD — It Pays
ABOVE CHART COVERS ROUND CARBON STEEL TUBING . . .
EQUIVALENT SQUARES, RECTANGULARS AND SPECIAL SHAPES ARE ALSO AVAILABLE.

Atomic Energy

"At the present time the supply of chemists and engineers equipped with the special knowledge required for positions in industrial hygiene is extremely limited. There is need at present for industrial hygienists at several of AEC's installations, and the expansion program will create requirement for others."

The stipend for the industrial hygiene fellows would be: $1,500 per annum if single; an additional $500 if married and $250 additional for each of two dependent children. If the fellow has completed one or more years of graduate work in a related field he will be allowed $200 additional.

There will be no written or verbal commitment on the part of the Commission or the applicants which would imply on the one hand that the Commission is obligated to provide the applicant with employment upon completing the training or, on the other hand, obligate the applicant to seek employment with the Atomic Energy Commission or its contractors. All candidates would be required to have a security investigation before being appointed.

The program will be administered by the Atomic Energy Project, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

TESTING REACTOR

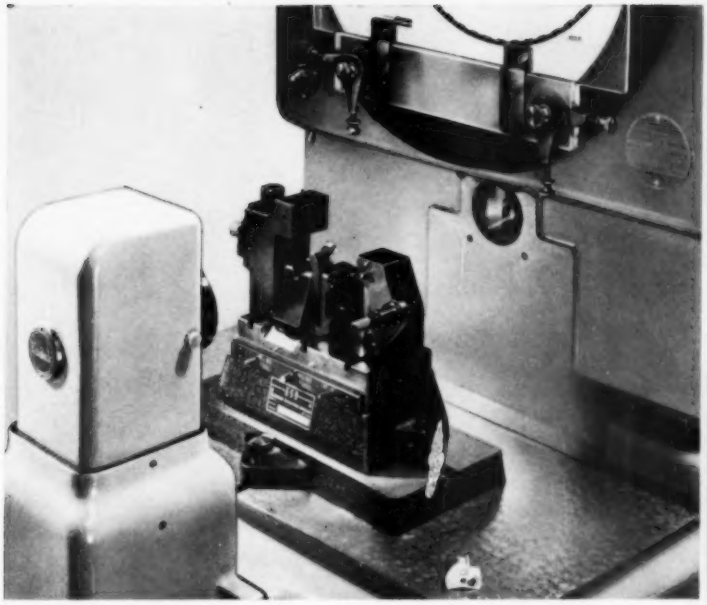
A materials-testing reactor, designed to produce a flow of intense neutron radiation, is now in operation at the National Reactor Testing Station of the U. S. Atomic Energy Commission.

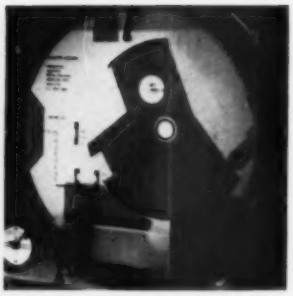
Research and development for the materials-testing reactor was done by the Argonne and Oak Ridge National Laboratories and engineering design by the Blaw Knox Construction Company of Pittsburgh. The Fluer Corporation of Los Angeles was the major construction contractor.

A mock-up, or pilot model, was constructed at the Oak Ridge Laboratory and used to aid the design and then to train operators. The reactor core was fabricated at Oak Ridge and shipped to the testing station for reassembly.

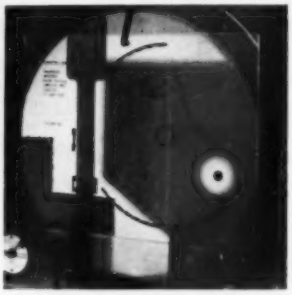
The reactor provides much-needed facilities for determining the effect of intense radiation on materials considered for use in the structures, heat-transfer systems, and shields of new reactors. A schedule for its initial use was established months ago.

The MTR contains more than one hundred ports in which specimens can be exposed to neutron bombardment. While the reactor operates primarily on thermal, or slow, neutrons, it also can subject specimens to neutrons with intermediate and fast energies.

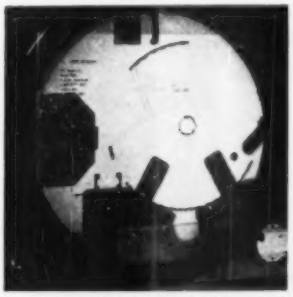




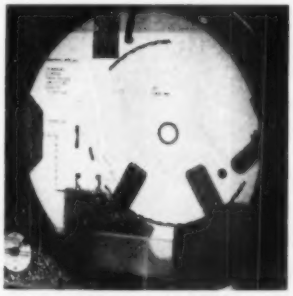
8 dimensions plus concentricity are checked to go and no-go limits on coordinated Chart-Gage Screen.



Hole location and straightness are checked by interposer Pin to Micro Gage tolerance line.



Interposer checks part thickness and counter bore depth to micro-gage tolerance line on chart.



Depth of holes are checked by interposer pin shown at top to tolerance limit lines on Chart.

27 Gages combined into *One!*

OPTICAL Projection Gaging has made possible a saving in gaging costs of over 500% on the small ROTOR part shown in the lower right corner of the above photo.

Twenty seven mechanical gages, and as many gaging operations, were formerly required to check the critical dimensions of this high production part. These 27 mechanical gages have been replaced by ONE PROJECTION GAGE and coordinated Chart-Gage Screen. Inspection time has been reduced from 4 minutes per part to 40 seconds.

Many Industries and Government facilities have experienced similar savings in their inspection costs when using Optical Projection Gaging.

Send us sample parts and specification prints for our analysis of how Optical Projection Gaging can help you or write and have our local representative contact you for personal conference.

A new film, entitled "Optical Gaging" is now available for showing in your plant upon request. This 16mm sound film produced by the Eastman Kodak Company demonstrates many of the cost saving factors obtained when using Optical Projection Gaging. Direct inquiries to:

OPTICAL GAGING PRODUCTS INC.

SUCCESSORS TO ENGINEERS SPECIALTIES DIVISION OF UNIVERSAL ENGRAVING AND COLORPLATE CO., INC.

26 FORBES STREET, ROCHESTER 11, N.Y.

SPECIALISTS IN PROJECTION GAGING

The Navy Is Ready

Air Power Is the Key to Continued Control of the Seas

A NEW atomic-powered submarine is now under construction at New London, Conn. Secretary of the Navy Dan A. Kimball believes that future aircraft carriers of the FORRESTAL class will be atomic powered.

Second Carrier Planned

Our alert, confident Navy which had argued for a long time for the necessity of building a second 60,000-ton aircraft carrier, capable of launching today's heavier and longer-range planes, was recently permitted by Congress to go ahead with such construction.

The first such carrier, to be named the FORRESTAL in honor of the first Secretary of Defense, the late James V. Forrestal, is budgeted at $218,000,000. The keel for this powerful craft was laid at Newport News, Va., in July by Secretary of Defense Robert A. Lovett. The cost of the second carrier is estimated at $204,500,000.

The Navy's share of the fiscal 1953 military budget is $12,265,157,642. The Navy will spend $3.5 billion of its allotment for the construction of aircraft and related procurement as compared with $580 million for shipbuilding.

Today's Navy is air-minded. One line officer out of every four in the Navy is a rated pilot in a flight status and the same percentage holds true for officers in the Marine Corps.

Every one in the Navy is thoroughly conscious of the fact that the ability of the Navy to deliver devastating blows for a sustained period of time at distances far removed from both continental and overseas bases is incarnate in naval aviation and that none of the other forms of striking power (amphibious forces, submarines, heavy fleet units) can have significant and continuous effectiveness without it.

We are indebted to the Assistant Secretary of the Navy for Air, John F. Floberg, for underscoring the fact that the United States occupies two per cent of the earth's surface and that its military security, as well as its economic and industrial vitality, are critically dependent upon commerce over the seventy per cent of the earth's surface that is covered by salt water.

The sea lanes must be kept open. Logistic support of our troops in Korea amounts to sixty-four pounds per man per day. It is the responsibility of our Navy to guarantee an open and safe sea path to the Far Eastern theater. No partial protection, no down payment on protection, will suffice. Logistic support, like maritime commerce, must be guaranteed protection wherever it moves.

Our country must maintain control of the world's seas. Control of the sea means the ability to preclude an enemy from use of the sea lanes, both coastwise and transoceanic, for his own purposes while possessing freedom of use of the sea lanes for one's own purposes.

Control Demands Jets

Control of the sea, however, is meaningless without control of the regions under and over the sea. More than twenty-four million tons of Allied shipping were sunk during World War II, principally by submarine and aircraft. Control of the sea today demands jet aircraft on big, fast carriers.

Adm. William Morrow Fechteler, new Chief of Naval Operations, is exceptionally qualified to guide the course of our Navy during this critical period. The Navy is ready today, and with the completion of the aircraft carriers now planned and under construction, plus a full quota of combat-ready aircraft, our Nation will be able to go on relying upon the Navy for the control it has traditionally maintained.

Adm. William Morrow Fechteler, Chief of Naval Operations, whose photograph appears on the front cover of this issue, is a combat veteran of both World Wars.

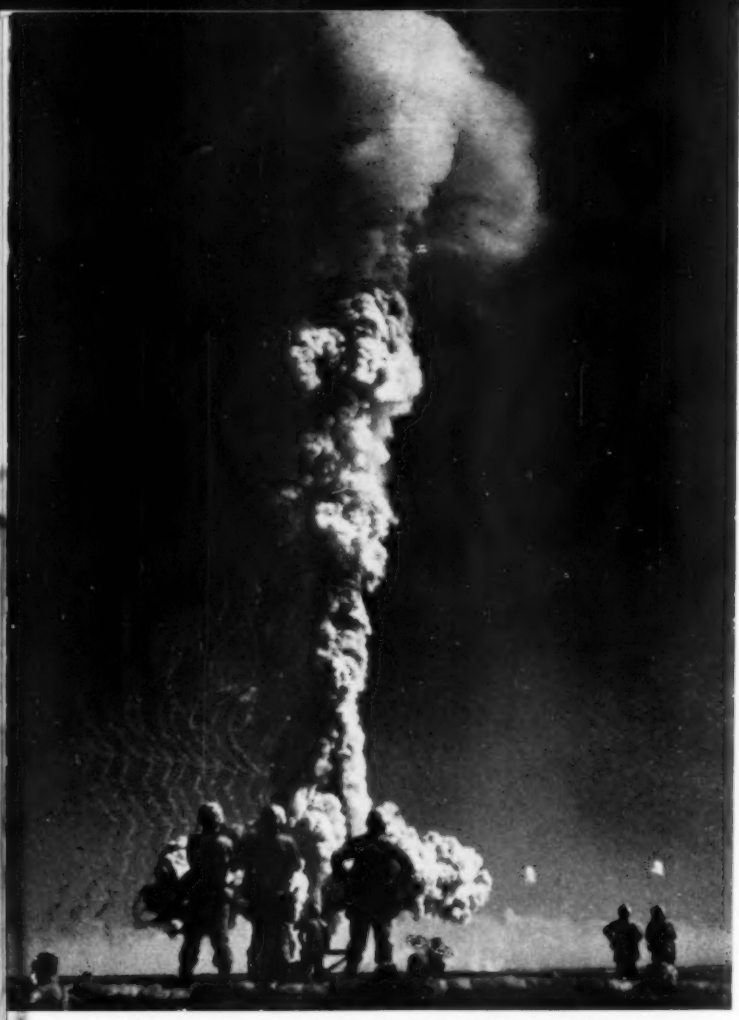
A graduate of the United States Naval Academy in 1916, he served on the battleship PENNSYLVANIA during World War I. Between the wars he was promoted through grades, served on destroyers and battleships in the Atlantic and Pacific Fleets, and had a tour of duty in the Asiatic Station.

Shortly after the outbreak of World War II he directed the assignment of officer personnel for the Navy and then went to sea in command of the new battleship INDIANA. In 1944 he commanded Amphibious Group Eight and conducted successful landings in the Admiralty Islands and in the Hollandia, Biak, and New Guinea operations. He also participated in the reconquest of the Philippines.

In the postwar era he was Assistant Chief of Naval Personnel, Commander of Atlantic Fleet Battleships and Cruisers, and Commander in Chief, Atlantic and U. S. Atlantic Fleet, with additional duty as U. S. Representative, North Atlantic Ocean Regional Planning Group, North Atlantic Treaty Organization.

During this time he was chosen by the United States to be the Supreme Commander, Atlantic, of NATO naval forces, but agreement with Great Britain was not concluded by the time he assumed his present post as Chief of Naval Operations on August 16, 1951.

"KEEP YOUR POWDER DRY" *might well be the watchword of these U.S. sailors as they unload powder and 8-inch shell from a barge to a waiting warship for bombardment of the enemy in North Korea (Navy photo).*



U. S. Marines gaze up at atomic cloud during tests in Nevada (Defense photo).

A New Look at the Atomic Bomb

A valuation of the limitations and powers of the nuclear weapon

Maj. Gen. J. F. C. Fuller

WAR is either a senseless slaughter or an instrument of policy, and, whether policy be wise or foolish, its aim is something the would-be victor considers worth fighting for and winning. Even in the case of barbarous nomadic tribes, the massacre of entire populations and the destruction of cities are acts of policy because their aim is to win grazing grounds and not slaves or dwellings.

Because policy has an aim, it follows that war has a limit, and even if the aim is to conquer the entire world, the means employed should be limited to those actions which will enable the world conqueror to attain his end at the highest profit. Otherwise stated, a profitless aim is nonsensical, and, whatever the means employed, war without a profitable aim is blind slaughter in which victory and defeat are measured out in corpses.

In another war, what is the aim

General Fuller, noted British soldier-author, is one of the outstanding military analysts and historians of the present day. He is a frequent contributor to ORDNANCE.

going to be? This is a question of importance.

80,000 Casualties

When seven years ago the first atomic bomb incinerated in seconds 80,000 people in Hiroshima and in the act rent asunder the veil of six years of frantic propaganda, this question blazed out before a terror-stricken world. And although man's horse sense told him that unlimited war was insane, he did not pause to think. Had he, he would have realized that it was not the atomic bomb or any other weapon which had bereft war of all reason—it was his propaganda-stimulated emotions.

Had he understood this, instead of shouting for the abolition or control of the atomic bomb, he would have demanded the abolition or control of the radio, an incomparably more potent weapon, because it can transform entire nations into homicidal lunatics. The 80,000 in Hiroshima perished instantly because he had already rendered war insane—and not because a new weapon had been invented.

The fact now is that neither emotionalism nor reason can abolish the atomic bomb, for like the radio it has come to stay. No international inspection or solemn agreement can alter this fact, for *vis à vis* mass-man and his emotional disequilibrium, one and all are meaningless. And as the A-bomb has come to stay, it will be used either as an instrument of policy or of blind slaughter.

If as the first, since it is now possible to pack the explosive energy of 20,000 and more tons of TNT into a single missile, clearly the present practice of war will have to change. Nevertheless, like all other weapons, the military usefulness of the atomic bomb will be governed by its limitations and the defensive measures taken to neutralize it.

As I see it, and as I suppose most of my readers do also, the atomic bomb is a special weapon, like the heavy siege howitzer or the classical battering ram. Basically, it is three bombs in one—a trinity of destructive power. It is a superexplosive bomb, a superincendiary bomb, and, like a lethal gas bomb, it can produce toxic effect. This is both an advantage and a disadvantage.

Some Advantages

Advantages over the high-explosive bomb are that it is more economical for the destruction of large targets; that destruction is instantaneous instead of progressive, as normally is the case with high-explosive bombing; and that the materials it is composed of deteriorate so slowly that it is possible to stock-pile atomic bombs indefinitely.

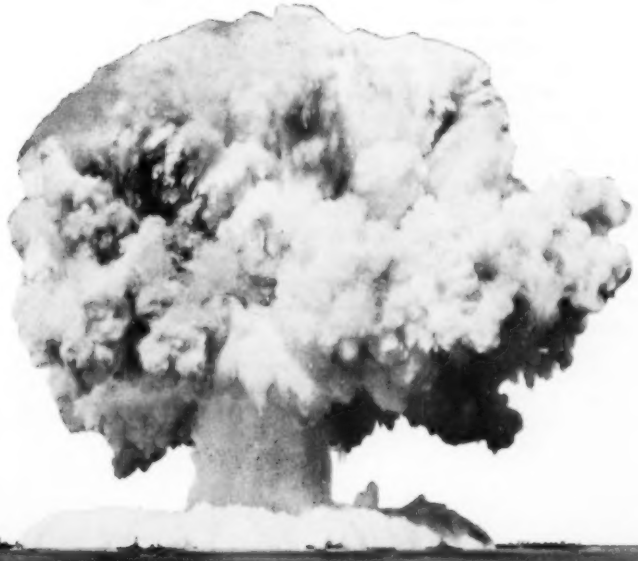
On the other hand, a disadvantage is overconcentration of its destructive power. Accepting the energy released as equivalent to 20,000 tons of TNT, it has been calculated that one-tenth of this figure carried in high-explosive bombs will effect a commensurate damage.

Radioactivity

The most marked difference between the atomic and HE bomb is the production of radioactivity by the former, both within the effective radius of its explosion and, on occasion, far beyond it, particularly so when detonated in deep water because of the radioactive spray thrown up. The radioactive materials created, either in the form of dust or particles of water, can cause casualties over some distance, and decontamination is both difficult and lengthy.

Although radioactive poisoning is a decided advantage when ground is to be denied or abandoned to the enemy, it is as great a disadvantage when it is not, and particularly so if it has to be occupied immediately after detonation. It would, however, appear that when an atomic bomb is detonated high in the air the radioactive effect it has on the ground is, normally, insufficient to incapacitate troops crossing it.

Relative to this question is the independent employment of radioactive materials—that is, of those not created by a nuclear explosion. These, in the



Navy photo

form of by-products, can be produced in great quantities in atomic piles, and should they be sprinkled on the surface of the earth will render it highly radioactive.

It is an open question and one which demands deep consideration whether this form of nuclear warfare will not eventually prove of greater military value, more especially in defensive operations, than the use of the atomic bomb itself.

Three Peculiarities

Three further peculiarities must be mentioned. The first is the cost of producing the atomic bomb, which, as far as can be foreseen at present, is likely to remain so high that only the more wealthy nations will be able to afford it. This means that in another war it will be only in the hands of three or four of the greater powers and that the lesser, if they are to obtain it, will do so at the expense of the former.

The second peculiarity, which is closely related to the first, is that atomic bomb manufacture is slow. In fact, so slow that, unlike other weapons, the bomb cannot at present be produced in large numbers in wartime. The consequence of this is that during a war the bulk number of bombs which can be used will depend on the belligerents' stock piles. Therefore, those who possess them will be reluctant to supply their nonproducing allies with bombs.

The third peculiarity, though extraordinary, should be obvious. It is that, even should a nation be wealthy enough to manufacture atomic bombs and guided missiles in bulk, it must have close at hand adequate testing grounds if efficiency and rapidity of production are to be guaranteed.

Thus it is farcical to suppose that in England efficiency can be secured if production is carried out at, say, Woolwich Arsenal, and experimentation on the Woomera range—13,000 miles away. As the latter cannot be shifted to England, it would seem that before long the former will have to be shifted to Australia. Though this limitation does not apply to the U.S. and U.S.S.R., it does apply to many European countries.

Further to the above are two riders. The first is that, because atomic warfare is largely governed by stock-piling, no would-be aggressor is likely to hazard a war unless he is confident that he has stock-pile superiority.

From this it may be deduced that the size of the stock piles, more so than the atomic bomb itself, is at present one of the main deterrents to the outbreak of war and that once the hydrogen bomb becomes a practical proposition its stock-piling will strengthen this deterrent.

The second rider is that, should radioactive poisons be accepted as a profitable major weapon, in order to find a substitute for them the less wealthy nations—also the more wealthy—are likely to turn to bacteriological war.

In support of this, because the cultivation of lethal bacteria can be carried out in any well-equipped laboratory it is as cheap as the manufacture of atomic bombs is expensive.

Therefore, should the extreme potency which experts claim for this type of war be correct, it would seem at least likely that bacteriological war will be resorted to in spite of Western man's inborn antipathy to the use of poisons as weapons.

Opposite Courses

From this brief summary of the powers and limitations of nuclear weapons I will next turn to their development in the last seven years. Here one is at once faced by the blackout of secrecy. Little has been divulged; yet from what has been, it would appear that two diametrically opposite courses are being pursued, the one leading toward increased destructive power and the other toward reduced power.

The first has already been so advertised that it is unnecessary to elaborate it at length. Briefly, we have been told by competent writers that a bomb containing 1,000 kilograms of deuterium (double hydrogen) will release an energy of 20,000,000 tons of TNT and that it will effect a total destruction over a radius of ten miles and severe damage over a radius of twenty miles. Further, should its casing be packed with cobalt—an element which can be rendered intensely radioactive—it is possible to poison the atmosphere to such an extent that all life will be obliterated in an area of thousands of square miles.

"The atomic bomb is three bombs in one—it is a super-explosive bomb, a superincendiary bomb, and, like a lethal gas bomb, it can produce toxic effect."

Interesting Problem

The second problem—that of the reduction of destructive power—is more interesting militarily. Last October and November news was released that at Frenchman's Flat, Nevada, experiments had been carried out with atomic weapons suitable for the use by and against ground troops.

Since then other trials have followed, and the Joint Congressional Committee on Atomic Energy has announced that atomic bombs can now be used on the battlefield to open the way for ground attack without fear of radiation hazards to the attacking troops. What type of bomb was employed has not been divulged.

Meanwhile, since 1945, defense against the atomic bomb has been proceeding apace. The development of radar, the introduction of the jet interceptor and of guided missiles moving at the speed of a bullet and equipped with the proximity fuze have advanced so rapidly that it would seem likely that the vast bombing fleets of the last war are things of the past.

Further, it would also appear that the odds against single machines carrying atomic or hydrogen bombs reaching their targets are progressively mounting.

Nevertheless, defense can never be absolute, and though as far as important military objectives are concerned attack may be made so costly that an attacker will think more than once whether the target is a profitable one to strike at, should war be unlimited there is no general defense foreseeable at present.

Should a belligerent resort to radioactive poisoning on a vast scale, except

for hasty evacuation there would appear to be no answer to it. Very naturally, in order to stimulate morale the defensive in nuclear warfare is played up, but this should not delude the student that this type of warfare can be made sufficiently absolute to be defensively unanswerable.

With the above developments in mind I will next examine briefly their strategical, tactical, and political significance.

In the last war, strategic bombing had three aims: to destroy the enemy's industrial resources, shatter his civilian morale, and demolish specific military targets. Normally the first and second aims were effected by area bombing and the third by selective bombing. The purpose of the one was to "brown" the target and of the other to hit it directly. The difference was that between shotgun and rifle.

In the last war selective bombing generally paid a high dividend while area bombing was a costly and unremunerative investment. Faced as we are now with atomic bombs and guided missiles, probably carrying atomic warheads, the question is, will these judgments hold good in the future?

Large Targets

Bearing in mind that with these costly weapons there must be a fair chance of hitting the target, it would seem that large targets usually will be selected, and obviously they must be within range of the means of carriage or propulsion. Should this be by rocket of the V-2 type, then, so I understand, until a more effective propellant is discovered the range is likely to remain what it is—in the neighborhood of 200 miles.

But should it be by airplane, then, in face of radar defense, the machine will either have to fly at so high an altitude as to make the hitting of even a large target problematical or at so low a one that it will have the greatest difficulty in reaching the target at all.

It would seem probable, therefore, that in order to obscure its identity the machine carrying the atomic missile will have to be accompanied by a fleet of ordinary bombers and fighters and risk getting through the enemy's defenses. Should this be so, then the prevalent idea that bomber fleets are obsolescent will have to be modified.

"Should radioactive poisons be accepted as a profitable major weapon, in order to find a substitute for them the less wealthy nations—also the more wealthy—are likely to turn to bacteriological war."

When the target is situated on or near the enemy's coast line, two other means of delivery can be employed. One is the use of merchant craft to carry the atomic bomb and detonate it in an enemy port, and the other is bombardment by submarine equipped with guided atomic missiles.

The Major Danger

The first could scarcely be resorted to after the opening of war, but the second, a very likely occurrence, is probably the major atomic danger now facing the U.S. and Great Britain. For instance, were London to be obliterated the greater part of England would temporarily be paralyzed, not because of the vast population or political importance of London but because it is a great port and distributing center.

Reverting to the main question—the strategical influences of atomic weapons in another war—I think it may be accepted that selective bombing is likely to be the order of the day and that the targets will, as in area bombing, remain large ones, including cities, seaports, great airfields, extensive oilfields, mining areas, and also larger concentrations of troops on land or sea.

As regards the atomic bombing of troop concentrations on land, unless they are situated in the enemy's country it is only likely to be resorted to in very exceptional circumstances because destruction of the enemy will also entail the slaughter and maiming of a large number of actual or potential allies.

And as regards sea concentrations, the question may well be asked whether, in the face of atomic weapons, great amphibious operations such as the landing in Normandy will be practicable? Also whether convoys at sea will not have to be dispersed over extensive areas and thereby render themselves easy prey to normal submarine attack?

Taking all in all, even should the above possibilities be only partially true, it would nevertheless appear that in a war between the Atlantic Powers and Russia the dice of strategic bombing are loaded in favor of the latter.

Next, I will turn to the main influence of the atomic bomb on tactics, which may be defined as the art of giving and avoiding blows. To reduce the human target, security demands the dispersion of force; and to increase hitting power, the offensive demands the concentration of force. The link between the two is mobility coupled, when possible, with surprise.

Because the speed with which atomic weapons can be delivered is so high and because the extent of their "beaten zone" is so vast, it is apparent that should both sides be armed with them the one which can disperse and concentrate the more rapidly—that is, possesses the higher mobility—has the advantage.

Disperse Rapidly

This problem has been examined by Maj. Lamar McFadden Prosser in the January-February 1952 issue of *Armor*, and what he says is this:

"Forces must concentrate only at the critical moment of the action and disperse rapidly thereafter. At this critical moment, and only then, should the force offer a profitable target to atomic weapons. The swiftness of the concentration must introduce the element of surprise and so reduce the danger of atomic annihilation."

Logically arising out of this need for extreme mobility is the displacement of masses of soldiers, either on foot or roadbound, by formations carried in tracked vehicles which, even though lightly armored, will go far to protect their occupants against heat radiation. As Major Prosser says, "that all troops will be mounted in tracked vehicles appears to be inevitable," and if so the oft-predicted last day of the tank will become more remote than ever.

Another point he mentions is the need to cut down the size of the huge

supply depots and long supply columns of the last war, and rightly he suggests air supply as the probable solution. One point, however, he does not touch upon which in my opinion is a vital one. It is the development of night movements and fighting until they become as simple and easy as in daylight. This should not be an insuperable problem for the scientist to solve.

War Is Emotional

The above arguments are, I think, rational and point to rational uses of nuclear weapons. Yet it must be remembered that war, even in its limited form, is a highly emotional act, and that as destructive power goes up emotionalism mounts with it. As this is so, the psychological influence of the bomb becomes paramount. Will man restrain his emotions in wars which are dominantly ideological—nay, *can* he restrain them in the age of the radio?

Though the atomic bomb is costly, though its manufacture is slow, and though, as the last war proved, bombing as the sole means of victory is a delusion, will man in the mass pause to consider these things? Besides, will not fear of a sudden surprise attack, on Pearl Harbor lines, so tamp emotionalism that long before a war breaks out reason will lose control?

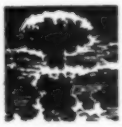
Unlimited Conflict

Even should such an attack not be made at the outset, will not fear of it be constant? Will not every military check, every reverse, be met with yells to use the bomb? In my opinion there is no question that this is not only probable but inevitable. Further, even should nuclear weapons be restricted to military objectives, who is to judge their validity? Therefore I hold that whatever restraints may at first be shown, because of mass emotionalism, fired by propaganda, they will rapidly be swept aside, the conflict becoming politically aimless and therefore unlimited.

The idea that atomic bombing, by rendering organized warfare impossible, will compel an enemy to accept his opponent's will is a doubtful one. For should a virile enemy be deprived of his means of waging organized warfare, he can still resort to guerrilla war, the most primitive of all and a type of war which nuclear weapons can only vanquish by the radioactive poisoning of the enemy's entire country.

This apocalyptic possibility brings me to my final question: What is the political significance of nuclear warfare?

Today as in the past—though it is frequently missed—the real war is the diplomatic war, and as internationally you cannot argue from weakness, fighting forces are maintained in order that argument may be backed by strength. They are the pickled birch in the schoolmaster's cupboard.



Should diplomacy fail in its aim, force replaces argument, its aim being to deprive the enemy's argument of the force with which it is backed—in other words to disarm his argument and thereby compel him to accept his adversary's.

Changed Technique

Today, however, a vast change in the technique of diplomatic war is in the process of development. More and more, argument between governments is giving way to argument between each government and its opponent's people. The aim is not, as heretofore, to settle the argument by discussion but, instead, by subversion—that is, to persuade the enemy people to overthrow their government or compel it to accept its opponent's policy.

Such is the new diplomacy, vulgarly called "cold war." It is just as much the real war as was the old diplomacy, though on a proletarian instead of a governmental level.

Unless we understand this we shall continue to fight the new diplomacy with the old, which is tantamount to waging an existent war on the lines of the last one, and the all but inevitable result will be that we shall be beaten in the realm of ideas and out of self-preservation will be compelled to resort to force. How will it profit us?

Here we are faced with the vast change in power to wage war. To all intents and purposes the destructive power of nuclear weapons is unlimited. Since it is already possible to destroy life in an area many square miles in extent, it should not be far distant before it becomes possible to destroy every living thing on earth.

Too Destructive

What does this mean politically? It means, first, that as an instrument of policy war has become mutually too destructive to be profitable. As the last two wars have shown, though neither was an atomic war, the victor comes off almost as badly as the vanquished, and this, politically, does not make sense. Secondly, its destructiveness makes it the most potent backing man has ever had for argument, whether it be diplomatic or subversive.

In other words, the power to destroy is rapidly becoming war's most powerful deterrent, and since men will continue to argue, to avoid annihilation they will be compelled to restrict it to its psychological battleground—the clash between antagonistic ideas.

Not only must this be appreciated but acted on; for though the Atlantic Powers may find subversive diplomacy distasteful, they must not overlook the fact that, at bottom, Russia is an Asiatic country and that Oriental diplomacy has always been subversive in character—that is, based on terror and treason.

Bomb a Blessing

If they do act and, under cover of the atomic bomb as well as of powerful fighting forces, launch a full-scale "cold war" against the implacable enemy of Western culture and civilization, instead of being a curse, atomic weapons may be found to be the greatest of blessings.

For under their aegis, war, instead of being looked upon as inevitable, will become so unprofitable that it will cease to be—conflict being relegated to the realm of ideas. This, I hold, is the bomb's ultimate political significance.

"Should a belligerent resort to radioactive poisoning on a vast scale, except for hasty evacuation there would appear to be no answer to it."

The Brick House at Sandy Hook

It Nurtured Old Traditions and Fine Ordnance Officers

The professional and monastic atmosphere of the old quarters bred men who became the nucleus of ordnance research and development in an earlier day

A SINGLE stained-glass window, whose motif is the Ordnance seal or heraldic device, is located at the head of the main stairway on the second floor of the Officers' Club, Aberdeen Proving Ground, Md., where the sun can shine through it, bringing out the rich colors of the design. It is the sole link with the past—a lone memento of the "Brick House" at the Sandy Hook Proving Ground, N. J.

Officers' Quarters

The "Brick House" was the dwelling place of officers stationed at Sandy Hook from 1878 until the proving-ground activities were transferred to Aberdeen in 1918. And the Main Officers' Club at Aberdeen, a massive building of granite, is the present-day counterpart of its famous brick ancestor.

Sandy Hook is a peninsula in Monmouth County, N. J., which projects northward into the Atlantic Ocean toward the Narrows of New York Harbor, inclosing a part of Raritan Bay on its western side. The Governor of the New Jersey Colony issued patents for this land in 1665, and Richard Hartshorne was its first owner. A lighthouse has occupied the tip of the Hook from 1762 until the present. The British occupied it during the Revolution.

Lands Sold

In 1806 the Hartshorne family sold the lands on Sandy Hook to the United States, and in 1812 it was fortified by the Army.

The State of New Jersey ceded this tract to the United States for "so long as the said tract shall be applied to the military or public purposes of said United States and no longer." In 1950, the military having no further use for the area as a military installation, Sandy Hook passed back to the State of New Jersey. *Sic transit gloria belli!*

The necessity for an Ordnance proving ground or, as it was termed, an "experimental and proof ground for heavy ordnance" was brought to the attention of the Secretary of War by Brig. Gen. A. B. Dyer, Chief of Ordnance, in his annual report dated October 21, 1872. He cited that the Ordnance Department had been compelled to use the limited extent of ground near Fort Monroe, Va., for these purposes.

On November 12, 1873, a board of Ordnance officers consisting of Lieut. Col. T. T. S. Laidley, Maj. Silas Crispin, and Maj. T. G. Taylor was created and ordered to assemble at the U. S. Ordnance Agency in New York City on December 3, 1873, to select a proving ground for heavy ordnance.

Site Recommended

After exhaustive study this board submitted its report on June 16, 1874, recommending a proving-ground site on the upper end of Squan Beach in the vicinity of the villages of Point Pleasant and Squan, N. J. The board estimated the cost of the site, including the facilities, at less than $100,000, and recommended that the necessary funds be requested from the Congress.

As an expedient, the board recommended that a temporary proving ground be established on the Government Reservation at Sandy Hook, N. J. The Sandy Hook Reservation was then under the jurisdiction of the Chief of Engineers.

With the consent of the Corps of Engineers and under authority of the Secretary of War, dated August 7, 1874, a temporary Ordnance Department Proving Ground was established on the Sandy Hook Reservation.

Record Established

Something of a record in handling correspondence was made at this time. Major Crispin, commanding officer of the U. S. Ordnance Agency in New York, wrote on August 3, 1874, to the Chief of Ordnance asking the authority and $4,000 in funds to set up the temporary proving ground. This letter traveled to Washington, was acted on by the Chief of Ordnance, the Chief of Engineers, and the Secretary of War—all in the space of four days!

With the $4,000 at hand, temporary facilities were constructed, and amid

This article was prepared at the Aberdeen Proving Ground under the direction of Brig. Gen. Thomas K. Vincent, formerly director of Ordnance Training and Deputy Commanding Officer at Aberdeen, and presently Commanding General of Redstone Arsenal, Ala., the vast rocket-production center of the Army.

General Vincent asked that authorship not be ascribed to him due to the fact that a large part of the text is taken from an anonymous history of the Sandy Hook Proving Ground which is now in the archives at Aberdeen.

In making acknowledgment to General Vincent for his part in the preparation of this story, the editors would like also to acknowledge their indebtedness to the unknown author who wrote the original story on Sandy Hook which General Vincent used as the basis of his text.

It is our hope that the earlier author, despite the passage of years, may see these pages and that he will make his identity known in order that he, too, may share in the telling of a story which will be an inspiration to all Ordancemen, past, present, and future.—THE EDITORS.

humble beginnings the Sandy Hook Proving Ground was born.

The Ordnance Board

This new proving ground was placed under the control of the Ordnance Board, and all proof work was conducted by the board members assisted by a small Ordnance detachment. The first Ordnance Board to operate the temporary Proving Ground at Sandy Hook consisted of Major Crispin, New York Arsenal; Major Treadwell, Frankford Arsenal; Major Baylor, Fort Monroe Arsenal; and Captain McKee, Springfield Armory.

The members of the Ordnance Board who were stationed elsewhere than at Sandy Hook made the trip to the Hook via a small steamer called the ORDNANCE. This steamer was still operating between Sandy Hook and New York City in 1919, but its name had been changed, in the interim, to ENGINEER.

While on duty at the proving ground the Ordnance Board occupied a small temporary Engineer building as quarters, and the members were reimbursed for their actual expenses while on this temporary duty.

In 1878 a permanent set of brick quarters was completed at a cost of $12,500 for the accommodation of officers temporarily on ordnance duties at the Sandy Hook Proving Ground. The building soon acquired the name of the "Brick House," a term of distinction since all the other buildings at the time were of temporary wooden construction.

Payment Provided

In 1889 a provision of the Fortification Act provided for the payment of $2.50 per day (in lieu of reimbursement for actual expenses) to Ordnance officers on temporary duty at Sandy Hook Proving Ground and absent from their proper stations. The officers were permitted to occupy the Brick House while drawing this allowance, paying only for laundry, food, and a small amount for service.

This provision for reimbursement of expenses on a per diem basis to Ordnance officers only was extended in 1891 to provide the same for all officers temporarily on duty at Sandy Hook Proving Ground and absent from their proper stations.

The Sandy Hook Proving Ground was continued as a temporary establishment under the supervision of the Ordnance Board until October 31, 1890, when Capt. Charles Shaler, Ordnance Department, was assigned as its first permanent commanding officer. Thus was born the first proving ground of the Ordnance Department.

The following year, upon the recommendation of the Chief of Ordnance, Sandy Hook was definitely decided upon as the most suitable location for the Ordnance Department's proving ground and plans were made for its improvement and expansion.

Following closely upon this important decision, steps were taken to establish a course of instruction for young Ordnance officers in the design and construction of ordnance. Maj. Gen. William Crozier, who became Chief of Ordnance in 1901, brought this to reality, and in 1902 an Ordnance School was established at Sandy Hook Proving Ground, necessitating additions to the Brick House to care for the additional officer personnel. These were completed in 1904 at a total cost of $16,600.

Mission Continued

From that time on the Brick House continued to fulfill its mission of providing a "home" for officers temporarily on duty at Sandy Hook. The daily bounty granted by the Congress continued, and life at the "Brick House" went on without change until the transfer of the proving ground from Sandy Hook to Aberdeen, Md., on January 1, 1918.

The Brick House at Sandy Hook was an institution unique in the history of the Ordnance Department of the United States Army, and the years of its colorful existence cover that period of intensive development of ordnance which led up to the modern artillery matériel, powder, and projectiles which we have today.

The proving-ground activities originally consisted of the Ordnance Board with the later addition of a separate proof department and the Ordnance School.

The dominant idea underlying the Brick House was the tradition that the importance of the work carried on at the Sandy Hook Proving Ground demanded the full, uninterrupted time and energy of every officer assigned thereto from early Monday morning until late Saturday night of each week.

Temporary Duty

Officers were, therefore, assigned only to temporary duty at the Sandy Hook Proving Ground, with their permanent stations at New York Arsenal, New York City, or other points in the vicinity sufficiently far removed from the proving ground to prevent an officer returning to his home except over Sunday.

The quartering of officers' families at or near the proving ground was contrary to the basic idea and was always officially frowned upon even though in later years some of the Ordnance officers on proof work did occupy quarters at Fort Hancock, N. J., which was located on the Sandy Hook Reservation.

The steamer ORDNANCE left its wharf at the Battery, New York City, every Monday morning at 7:30, and all officers temporarily on duty at Sandy Hook, regardless of rank or home station, were required to be aboard the boat at this early hour. The officers left the proving ground by the same steamer at 4:30 p.m. every Saturday, arriving in New York City at 6:30 p.m., except during the three summer months when the steamer left the proving ground at 1:00 p.m.

Punctual Routine

The daily routine at the Brick House, observed with the strictest punctuality, is now recalled with considerable interest. The officers were quartered on the second and third floors, and they were awakened every morning at 7:00 a.m. Breakfast was served at 7:30, and the whistle blew at 8:00 o'clock at which time every officer was at his desk in the main office ready to begin his day's work.

At noon the officers returned to the Brick House for lunch, and work was not resumed until 1:00 p.m. The afternoon work terminated with the blowing of the whistle at 4:30. From 4:30 until 6 o'clock officers were required to engage in some form of physical exercise.

Formal Dinner

At 7:00 p.m. a formal dinner was served, with all officers wearing their blue dress uniforms. It was the custom at both lunch and dinner for all officers to enter the dining room in a group, with the senior officer in the lead, as soon as the meal had been announced.

Dinner at the Brick House was rather a long-drawn-out affair, and, as at other meals, it was the invariable custom for every one to "talk shop." The daily activities of the Ordnance Board, which closely supervised all proof work, were generally argued and discussed in great detail, members of the board calling upon junior officers for salient details of their proof work.

Officers were seated at a long table in accordance with their rank, the commanding officer sitting at the head of the table and the mess officer sitting at the foot. The younger student officers generally found themselves grouped together near the foot of the table. Although their dinner-table conversation may not always have been confined strictly to shop talk, it was always carried on in low tones and without any hilarity which might in any way interfere with the more official remarks being made at the upper end of the table.

Back to Work

No one left the dinner table until the senior officer arose. He left the room first followed by the others, more or less in order of rank. Dinner, with its discussion of the day's activities, generally ended shortly before 8:00 p.m., and upon leaving the dining room all officers again went to the office to take up their evening work.

According to custom and tradition, no officer, unless he was actually ill or had good and sufficient official excuse, such as making a formal call, could leave the office in the evening until after 10:00 p.m. With the older officers it was generally a much later hour when they actually left their desks.

Moved from the "Brick House" to Aberdeen in 1950, the stained glass window above is cherished as a picturesque reminder of a great Ordnance tradition.

The student officers, after a long day of close application to their studies, were generally among the first to leave the office in the evening. This was not always the case, however, as the evening office contacts of the young officers with the older members of the Ordnance Board were very pleasant as well as instructive.

A Hard Grind

It was a hard grind to which the officers at the Sandy Hook Proving Ground cheerfully consecrated themselves, but the accomplishments certainly justified their labor. That particular period of ordnance development demanded unusual effort and application, and the officers assigned to the work unstintingly gave their best in helping to bring about the notable achievements of the Ordnance Department of that time.

It would not be fitting to omit from this brief story some reference to the lighter social side of life at the Brick House. Upon rather rare occasions the officers gave what they called a "Brick House dance." These were occasions when the strict routine of the House was temporarily set aside.

Wives and other invited guests came down from New York City on the afternoon boat. There was some crowding up of the officers on the third floor of the Brick House so as to make available sufficient quarters on the second floor for these guests.

A grand dinner in the evening preceded the dancing. Officers and ladies from Fort Hancock invited to the party contributed to the gaiety of the occasion, and the dancing generally continued late into the night.

On the morning following the dance the invited guests would depart on the ORDNANCE for New York City, and the Brick House would immediately resume its studious atmosphere of technical discussion and official activity.

Soon But a Memory

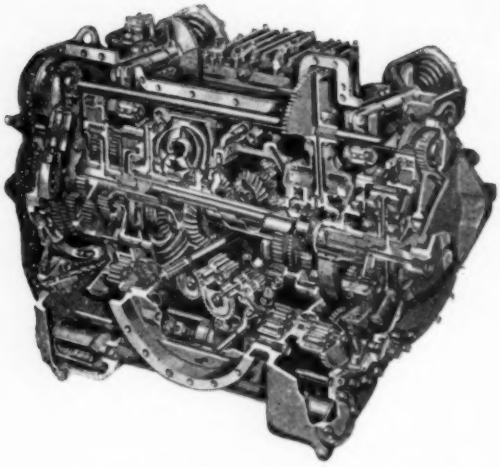
With the passing of Sandy Hook Proving Ground the Brick House became but a memory as did the advanced rank upon assuming a detail in the Ordnance Department, the $2.50 a day extra allowance while at the proving ground, and the monastic life led by the Ordnance officers so assigned, and the mantle of responsibility for the Corps fell upon the Aberdeen Proving Ground.

The Ordnance Board is still functioning but without the full charter which it enjoyed in the days of Sandy Hook. The Ordnance School with its training of officers and enlisted men, many times larger than its parent school, thrives on transplanted soil. The other proving-ground functions, enhanced by thirty-four years of progress, have overflowed the acres of Aberdeen and some of them are carried on at White Sands Proving Ground in New Mexico.

Windows Preserved

When the Sandy Hook Reservation was returned to the State of New Jersey in 1950, Brig. Gen. Charles D. Y. Ostrum, the last commander of Fort Hancock and Sandy Hook Reservation, had the two large and two small stained-glass windows, each of which bore the Ordnance escutcheon, removed from the Brick House.

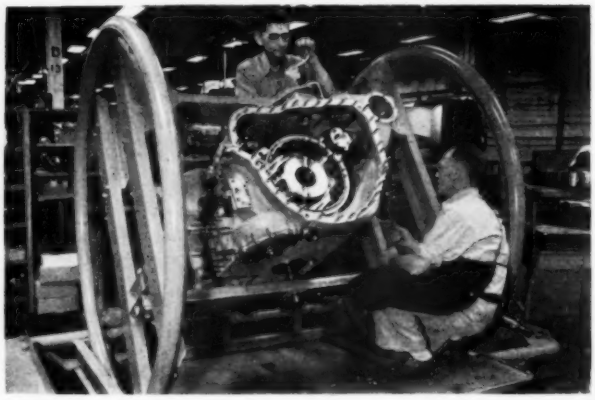
These windows were appropriately transferred to the Aberdeen Proving Ground, where one of the larger ones is permanently installed in the Officers' Club. As the young Ordnance officers of a newer day pass to and fro in the warm rays from the old window, perhaps they may be reminded, now and then, of the fine old Ordnance traditions that were born and bred in the "Brick House" at Sandy Hook.



Cross section, above, shows hundreds of the 4,000 parts that make up the Allison CD-850 tank transmission.

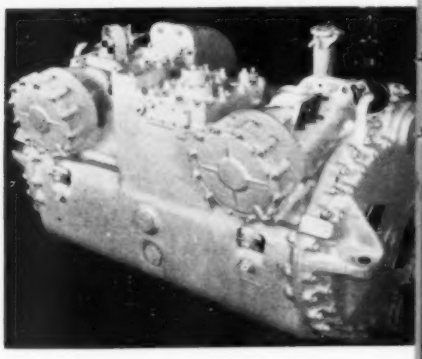
Milestone of Production

Recently the 10,000th cross-drive transmission rolled off the assembly lines of the Allison Division of General Motors at Indianapolis, Ind. First delivered to the Army in February 1947, the Allison CD-850 and the later model, the CD-500, transmissions are now an essential part of the Army's new line of medium tanks. To Allison's latest milestone in the history of American production—congratulations!



Almost 1,700 machine tools are required to turn out the CD-850 cross-drive transmission shown above receiving final assembly by Allison technicians.

Ready for delivery, below, the CD-850 tank transmission weighs 3,000 pounds, but is engineered into approximately 53 x 40 x 30 inches.



Powered by the Allison CD-850 transmission, the new Patton 48 tank is tested successfully at the rugged Delaware Tank Plant course.

Newest of the Army's medium tanks, the Patton 48, shown below, owes much of its maneuverability to its powerful Allison CD-850 hydraulic transmission.

Army photo

Ammunition Expenditure in Korea

The Cost of "Trading Metal for Flesh" in the Far East

By
Mark S. Watson

ACCUSTOMED as the American public ought to be by this time to the incredible (if not to the impossible), there was a good deal of astonishment this summer over the Pentagon's mention that expenditure of ammunition per weapon per day in Korea has been running above that of World War II. In some cases it has been running very much higher, and in the case of new types of ammunition, necessarily, the total expenditure (as well as the rate per weapon) has reached new heights.

Bazooka Ammunition

Thus 3.5-inch bazooka ammunition was heavily expended in the period when Communist tanks provided a target; eventually it supplanted altogether the smaller World War II bazooka ammunition—but as there were no 3.5 bazookas in World War II, comparison in this item is pointless.

Surprising Facts

Since that time surprising facts about ammunition expenditure in Korea have come to light through agencies which normally are averse to that sort of announcement—and in spite of their normal "security" restrictions. For it was necessary for the defense establishment, and more particularly the Army, to lay the sobering ammunition facts before Congress and the public in order to make sure that excessive economies in defense appropriations did not cut into the irreducible requirements for ammunition.

In his determination to avert that extremely serious peril, therefore, Gen. J. Lawton Collins, Army Chief of Staff, bared the situation pretty thoroughly. He listed the extremely small appropriations for ammunition between 1946 and September 1950, remarked on the training requirements of that period which used up most of the small purchases, touched on the unsatisfactory condition of much of the old stock, and noted that "big money" for ammunition replenishment did not reach the Army until January 1951.

Long Lead Time

So long is the drag between contract making and contract delivery for ammunition, as for most other items, that the bulk of the orders placed in January 1951 did not even begin to come from the factories until June 1952, and most of those orders are due in fiscal year 1953.

In the meantime it is rather startling

Mr. Watson is an internationally known war correspondent and staff member of the Baltimore *Sun*. He is the author of "The War Department, Chief of Staff," and other works, and received the Pulitzer Prize for international correspondence in 1945. In 1947 he was a member of the U. S. Mission to China and Korea.

to learn from official sources that our Korean requirements have been met almost wholly from the Army's reserves —mainly the residuum of World War II accumulations. This naturally has greatly reduced our stocks both in overseas bases and in the United States, while rationing of certain types has been necessary in Korea.

Disturbing Thought

It is disturbing to consider what would have happened if the Korean action had continued in full cry instead of dwindling away during the first year of truce negotiations. Still more disturbing thoughts arise over what would have happened if a full-sized war on the other side of the globe had developed in 1951 or 1952. A sober observer must recognize that if America is not the permanent favorite of the fates, she continues to act as though she were.

In the lively midsummer discussion of the shortage of certain ammunition types, referred to warningly by General Collins at congressional committee hearings (the shortages referred to were primarily in the build-up of necessary reserves), perhaps insufficient attention was paid to one all-important point—the troops in the line in Korea have been getting their requirements all right for a long time. The shortages in numerous mortar and artillery categories in the desperate early days are well remembered, but they were corrected (in the realm of field supply) with good speed.

General Collins' concern, inevitably, has been not only with current combat requirements but with the building up of reserves for Korea, for all other possible theaters as well, and for home defense itself. The layman has a very sketchy idea of how immense are the reserves of ammunition which must be maintained against possibilities which cannot be predicted.

How heavily did the Army cut into its old stocks of ammunition? In a modern "action," as compared with a world war, how heavy is the expenditure of artillery and mortar shells, of mines, of rifle and machine-gun cartridges, etc.? What are the new rates of fire and hence the new bases of computation of needs in varying types of operation?

To these and related questions no precise answers can be made while the Korean action is still on and other actions are possible, but from General Collins' concise statement of 1953 requirements (May 19, 1952, in a letter to a Senate committeeman supplementing Army Secretary Frank Pace's communication of May 7, 1952) this interesting passage may be quoted:

High Fire Rates

"Please note that almost immediately after the fighting in Korea began the Far East Command requested and obtained approval for rates of fire for four basic types which were several times greater than World War II rates. Although these proved higher than necessary and have been revised downward, it should be pointed out that in several very important types of ammunition the rate of fire per weapon per day in Korea has remained substantially above the World War II rate. [Note: Secretary Pace addressing a Senate subcommittee on June 18th spoke of rates at periods "almost three times" those of World War II.]

"The effect of these higher authorized rates was to decrease the existing supply in terms of days that it would last. It was very serious in the case of those types where the depot stocks were relatively low and where a considerable proportion of the existing stocks required renovation before shipment. As a consequence, these types did not reach the theater in sufficient volume to support the authorized rate and to build up a reasonable operating reserve. Thus among some types of ammunition it was necessary to ration the amounts available almost from the beginning of combat in Korea."

Four Basic Types

The specific types referred to were revealed in accompanying charts, not publishable as is the letter itself. The only official identification has been of illuminating shells (indispensable in Korea where the enemy frequently made night attacks), and this identification presumably is permitted only because, long before now, that particular shortage has been met. The "four basic types" for which Far East headquarters originally sought authorized rates of fire "several times greater than World War II rates" are not formally identified, but the character of the fighting readily suggests that these would be basic types of mortar and field artillery, which have been the main stand-by of ground fighting in Korea as in kindred combat anywhere.

Old soldiers will ask why this should be. And when an old artilleryman who was brought up in World War I techniques finds out how much artillery ammunition is expended today and how many of the enemy are put out of action as a result and computes the altered cost of killing one enemy soldier, he is likely to remember the advice handed down to him thirty-five years ago when he used up more than his daily allowance of shells. It came from General Pershing and was to the effect that the Old Man did not want a salvo of 75's used to kill an enemy who could be killed by a Springfield rifle in the hands of a proper rifleman.

Problem Not Easy

The problem is not quite so easy, however. The enemy soldier may be several feet underground somewhere in a rather wide area where a rifle bullet cannot reach, in which case quite a lot of high explosives must blow up the whole area. Or there may be a few thousand enemy soldiers coming hell-bent toward one of our thinly held positions. In that case a great deal of fragmentation shell is needed in a hurry.

If we have, on many such occasions, spent more artillery and mortar ammunition than was necessary, that is a lot better than spending less than was necessary.

In the somewhat grisly explanation of one of our logistics chiefs, we have been "trading metal for flesh." There are plenty of times when a commander must accept sacrifices of personnel, for that is a part of war; but the aim is

to avoid unnecessary sacrifices, and if massive firepower will accomplish the needed results without serious losses among our own troops, the commander will spend ammunition freely, and his judgment will be supported.

We have made a good deal of progress in this respect—in World War I over the Civil War, in World War II over World War I, and now in Korea. This is the way General Collins puts it:

Low Death Toll

"It was our superiority in mobility and firepower, as well as our high standard of medical care, that kept our Army battle-death toll during World War II down to less than thirteen per cent of that suffered by armies that faced ours. We accomplished this in spite of the fact that we conducted operations in many widely separated parts of the world, over fantastically long lines of communication, and often with strategic inferiority in numbers of troops.

"Since World War II we have increased the firepower of our infantry divisions by almost seventy per cent with only a twenty per cent increase in personnel.

Overwhelming Odds

"In Korea, our troops have had to face overwhelming numbers of enemy troops and in order to offset that superiority in numbers—at times almost thirty to one—have had to employ an unusually high rate of fire. In some instances our rates of fire there have been as much as twice the normal expenditure in World War II. To those who say this is excessive our answer is that we are pinching pennies wherever possible but we never pinch pennies where the life of a single one of our men is concerned."

It is a trend common to all services, of course, dictated not only by the universal desire to conserve American lives (in contrast with the total disregard for human life which is exhibited by the Oriental—or the slightly modified Tartar), but also by the changing character of weapons and techniques.

Long Bombardment

Thus, the Navy studiously has been bombarding the area about Wonsan, on Korea's eastern coast, daily since February 16, 1951, which seems to be the longest continuous naval bombardment in history. Not a great many Reds are killed by it, but a great many of them are kept from moving down the east road against the American line further south, and a great many are kept busy making road and bridge and rail repairs, and a great many are pinned to that vicinity, just to make sure that the United Nations Far East commander does not suddenly throw in a landing force which could crash into the Reds' flank and rear.

75,000 Tons of Shells

Altogether, before 18 months were out, the Navy had expended 75,000 tons of shells (including powder) and 50,000 tons of bombs; it spent only 16,000 tons of shells and powder and 1,500 tons of bombs against Iwo Jima in World War II and 47,000 tons and 8,500 tons, respectively, against Okinawa.

In aircraft rockets, the Naval expenditure in Korea for that period was 250,000, compared with 18,000 against Iwo Jima and 60,000 against Okinawa. For good measure one can add 36,000,000 rounds of machine-gun ammunition and 30,000 tanks of napalm poured into Korea.

Air Force data are equally interesting. Two years of Korea have used up 98,000,000 rounds of ammunition (against 65,888,000 in 1943 *in all theaters*). But 97,000 tons of bombs in Korea fall very far below the 1943 total when ruin was being rained on Germany. The spending of 264,000 aircraft rockets permits no 1943 comparison because rockets were not used until the next year.

Against the Korean total of 7,000,000 napalm tanks no good comparison is possible—in Korea they constitute an antipersonnel weapon, whereas the 37,000 used in World War II were incendiary instruments against buildings and dumps. But the figures show that both rockets and napalm are being used by the Air Force on a vastly

Empty shell cases at left are the result of 8 battalions firing 155 and 105-mm. howitzers (see below) for 15 consecutive days during a bitter attack in Korea.

broader basis than in 1944-1945, which is the main point under discussion with regard to ordnance. The present machine gun discharges 1,400 rounds a minute against its 1944 prototype's 800, itself an encourager to heavier ammunition expenditure.

Interesting Details

The Army refrains from providing over-all figures, presumably because if they are examined along with the Collins and Pace statements there would be an imperilment of necessary secrecy on ordnance procurement and expenditures. But it of course permits data on isolated events, and so one can provide certain interesting details of the dump rearward of the Second Division after the Americans' successful attacks on Hills 940, 983, and 773, near Inje, between August 18 and September 5, 1951 (see photo on page 253).

In that period there were 15 days of hard fighting against fanatical hordes of Reds showing total contempt for death. The division's 5 battalions of 105's fired an average of 10,000 shells for each of 15 days, and its 3 battalions of 155's fired an average of 7,500 shells.

This totaled something like 1,087,500 shells, and while a taxpayer would probably prefer not to know anything about it, this total at $30 and $40 per shell in the two calibers represents $36,000,000—for one division in one series of rugged battles.

Cost Justified

Costly, certainly, but how many American lives at how much per life, would have been sacrificed if victory had been sought with a materially smaller expenditure of shells or dollars?

The action was directed by Maj. Gen. Clark Ruffner as division commander, who since that time has made (as at the American Ordnance Association meeting at the Detroit Arsenal not long afterward) some interesting remarks on the manner in which the field commanders have been applying the principle to which General Collins has called attention. One of his battalions, he noted, fired 11,600 rounds in a 24-hour period. It was a record, so far as known, but a few days later it gave way to the record of another of his division's battalions, which fired 13,000.

Heavy expenditures of artillery ammunition, General Ruffner observes, kill enemy personnel not only above ground but below ground where rifle and machine-gun fire could not possibly reach them; also at great range far beyond the reach of small-arms, thereby making sure that none of these particular enemy forces will later get into our own lines. Great damage also is done in enemy assembly areas wholly concealed from ground observation.

Beyond this positive damage to enemy manpower, through the one-time smothering of such an area, the enemy is denied use of that particular area indefinitely thereafter, for once it is apparent that our guns are fully registered on it and we have gained observation of any sort, he dares not use that area or even cross in it transit. He knows he has lost it almost as fully as if we had actually occupied it.

Thus he is compelled to go elsewhere, perhaps to a less desirable area or perhaps by a circuitous route in the course of which he can be spotted and hit again and again. He is also embarrassed in his daily work of bringing up supplies and in evacuating his wounded. He knows that even by intermittent night fire on known traffic paths we can keep him out.

In Korea (as often was the case in other theaters), General Ruffner remarks, we have never battled for a town because it was a town, but simply because it was a road center. Wonju was the best road center in its area, and we fought over it for months, long after the town itself and the last of its miserable little huts had ceased to exist.

Great Disadvantage

If the enemy cannot move at good speed he is at a great disadvantage. Infantry usually covers about 2½ miles an hour—never mind the exceptional outfits like Stonewall Jackson's foot-cavalry and certain modern exemplars whose boasts suggest that these units must have been jet-propelled. If infantrymen are forced off the road they can do 1½ or so.

But if, as in Korea, they are forced to clamber over mountains or through rice paddies, infantrymen will do a lot less, and they will have to cache or throw away a lot of equipment, lessening the unit's value when it reaches its destination. That simple fact justifies a lot of artillery fire which hits nobody but which prevents a lot of people from occupying places we wish to keep vacant.

Air Power Curtailed

Airplanes, for all their incomparable merit on certain missions, may be denied access to the battlefield at a critical time. Bad weather in that area will keep them away from it, or bad weather may even pin them down to their own distant airbase.

But the guns roar away by day or night, come fair or foul weather, even when fog or darkness prohibits ground observation. Unobserved fire is expensive and rarely used if there is an ammunition shortage, but if a commander knows that the enemy is massed somewhere in Area B he will fire without observation, and his superior will support him in his "extravagant" decision. Many a night attack by a dangerous foe has been broken up that way.

Reasons Clear

The principles laid down by General Collins and illustrated by General Ruffner's remarks—coupled with the necessity henceforth of "trading metal for flesh" any time we can do so—make clear why in certain types we are using two or "nearly three times" as much ammunition per weapon per day as we ever did before, and almost certainly we will continue in that direction.

This patently calls for a permanent ammunition program very different from that of the years immediately following World War II when, as is America's complacent custom, we let down dreadfully in our state of combat readiness.

It would have been a lot better if we had maintained a normal pace in the peacetime years. That still is a good idea for the future.

Industry-Ordnance Teamwork

"FINEST IN THE WORLD"

"Physically, I think it is the finest medium tank in the world. It has the greatest speed, the greatest mobility of any tank of its type that we have produced. It has the greatest rapidity and accuracy of fire of any tank of its type that we have produced. It affords to the man who rides and fights in that tank the greatest protection that has ever been provided to American fighting men in this type of tank."—SECRETARY OF THE ARMY FRANK PACE, JR., *at christening ceremonies of the Patton 48 tank.*

The Army's newest and most advanced medium tank, the Patton 48, was publicly unveiled with appropriate ceremonies at the Chrysler Delaware Tank Plant on July 1st. Mrs. George S. Patton, Jr., widow of General Patton, escorted by her son George, christened the new tank. R. T. Keller, tank plant manager; K. T. Keller, Chrysler chairman; and L. L. Colbert, Chrysler president, also participated in the ceremonies.

The Aircraft Gun Problem

Should the Rifle or Shotgun Principle of Fire Prevail?

by

Col. René R. Studler

"The air target of aircraft weapons is a composite of personnel, fuel, power plant, and structure. The choice of armament providing the greatest lethality against this composite is a compromise involving lethality of individual rounds, weight limitations, and ability to hit the vulnerable target area."

"A GOOD big prize fighter can always lick a good little prize fighter." This type of generalization is all too often accepted as the basis for a similar generalization concerning aircraft armament—that a good big projectile is better than a good little projectile.

Factors Misunderstood

There are certain qualifications not always understood by the press and the public which must be considered in any discussion of aircraft armament. Lack of consideration of these factors has often caused our armament to be branded with the term "peashooters," and the armament designers have been told that they think in terms of "horse-and-buggy" days.

Colonel Studler is chief of the Small Arms Branch, Research and Development Division of Army Ordnance. Associated with the development of aircraft machine guns since 1917, he introduced incendiary aircraft ammunition during World War II. In addition to other Research and Development Board assignments, he is the Army member of a committee appointed by the Chairman of RDB to review aircraft armament.

This despite the fact that the record of air-to-air combat in Korea shows a ratio of between five and ten MIG kills to each U.S. loss.

The first qualification is that, to be effective, a projectile of any size which can in practice be fired from an aircraft gun must hit the target. The second is that it must arrive at the target with effective velocity.

A baseball is a good big projectile and a golf ball a good little projectile, but if one's head is the target, the baseball is less effective if lobbed a few feet by your 2-year-old offspring than the golf ball driven by a careless player.

It is interesting to note the reported comments of two new jet aces to emerge from "MIG alley." Maj. Donald E. Adams, who shot down his fourth and fifth MIG on May 3, 1952, to become America's thirteenth jet ace, publicly stated: "Recently MIG's have begun showing up with nothing but heavy machine guns like our .50's. Apparently they are finding out that the .50 is a mighty fine weapon."

Major Adams' report was supported by Capt. Robert T. Latshaw, who got his fifth MIG on the same day as Major Adams.

On the other hand, the July 23, 1951, issue of *Time* in an article headed "Aërial Slingshots" reported that in Korea our North American F-86 "Sabre" had to spray 1,400 rounds of caliber .50 fire from its 6 machine guns at a Russian MIG-15 fighter before it went down.

The *Time* article served as a springboard for the story published by *Interavia* reported and distributed to American readers by the president of the American branch of a well-known foreign arms firm. The name of the firm is associated with 20-mm. automatic cannon extensively used during World War II by the United States, United Kingdom, Germany, and Japan, among others.

Shotgun for Elephants?

This organization has never interested itself in weapons of calibers less than 20-mm. and is currently promoting 30-mm. guns as well as 20-mm. It is therefore not surprising that, with reference to the U.S. caliber .50, *Interavia* should quote the chief engineer of the arms division of the foreign firm as saying, "one doesn't go hunting elephants with a shotgun."

A comparison of 30-mm. projectiles weighing as much as a pound each with caliber .50 projectiles weighing but little more than an ounce each tends to support the quoted engineer.

However, it would be equally, perhaps more, pertinent to say that one doesn't go hunting ducks with an elephant rifle.

The air target of aircraft weapons is neither an elephant nor a duck. The air target is a composite of (1) personnel, (2) fuel, (3) power plant, and (4) structure. The choice of armament providing the greatest lethality against this composite is a compromise involv-

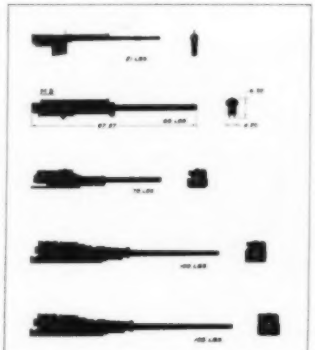


Fig. 1. Comparative size, weight, and profiles of caliber .50 aircraft machine guns of experimental and standard types.

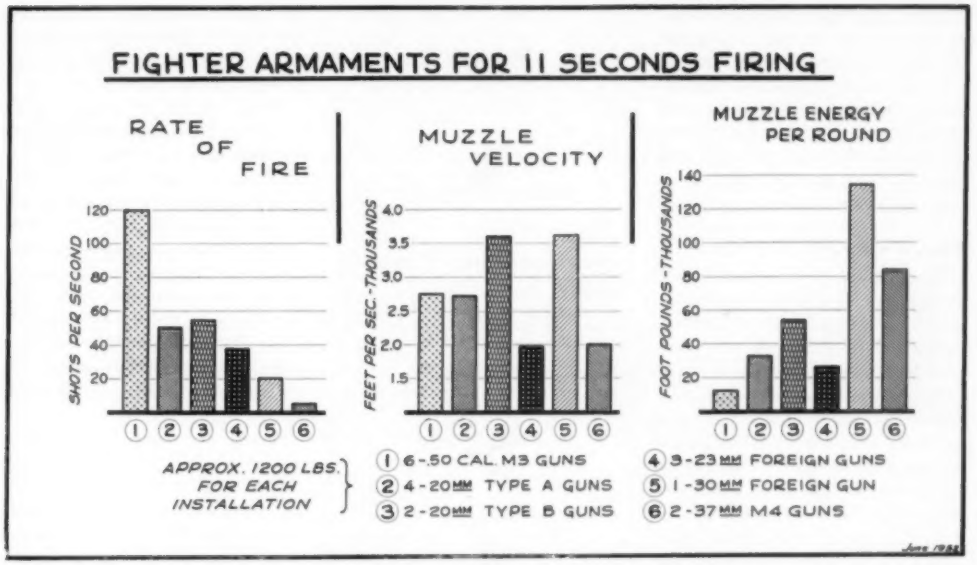


Fig. 2. Characteristics of different gun installations for a 13,500-pound fighter airplane with a 1,200-pound armament limit.

ing lethality of individual rounds, weight limitations, and ability to hit the vulnerable target area.

It has been well proved that projectiles as small as caliber .30 are adequately effective against personnel. It has also been well established that caliber .50 projectiles of the incendiary type have a high degree of effectiveness against fuel. Fuel carried by an aircraft may be the element of its own destruction.

It has been clearly established that other factors contribute more than does projectile size to the efficient initiation of fires by incendiary bullets.

Size Important

Against structures, size of projectile and, more particularly, the amount of explosive filler, are of predominant importance. Calibers .50 and .60 and 20-mm. projectiles have a low degree of effectiveness against structures.

Our fighters returning from combat with MIG-15's in Korea with several 23-mm. projectiles embedded in the structure of a single airplane are evidence of this low degree of effectiveness.

The dominant factor in the selection of aircraft armament as, in fact, in the selection of aircraft, is that of weight.

With respect to the total weight of an airplane of given characteristics any change in those characteristics involves a redistribution of weight. Greater speed calls for a higher percentage for the airframe and power plant. Greater combat radius calls for a higher percentage for fuel and tanks. If speed and radius are to be increased, the military load must be decreased.

Effects of Weight

Specifically, an increase in the weight of guns and ammunition carried by the F-86 may be expected to decrease its speed, rate of climb, and ceiling, which at present are approximately comparable to these of the MIG-15.

Air Force Secretary Finletter in a statement to *Look* magazine said, "I gave the figures a moment ago showing that we have knocked down nine MIG's for every F-86 that is knocked down." Since the planes are considered to be about equal in flight performance, the margin of superiority must be attributed to the pilot and his armament.

Fig. 3. Three 20-mm. guns which vary in weight by a factor of 5 due to differences in muzzle energy and rate of fire.

The major credit is conceded to the pilot. It is hoped that he will allot a small measure of credit to his weapons, without relaxing in the least his insistent and proper demand for better armament.

The MIG-15 has been armed with one 37-mm. gun and two 23-mm. guns, all three of which have relatively low cyclic rates of fire. The Russian 37-mm. fires at a cyclic rate of 400 rounds a minute and the 23-mm. at 700 to 800 rounds a minute—a combined rate of approximately 1,900 rounds a minute or 31 rounds a second.

Contrast Apparent

When one considers the 6 caliber .50 guns of the F-86, each firing at a rate of 1,200 rounds per minute or a total of 7,200 r.p.m., a major contrast in the armament systems is apparent. The ratio of rounds fired per interval of time is almost four to one in favor of the F-86.

What makes guns and ammunition heavy? Does an increase in projectile diameter mean a heavier gun? Not at all. The 57-mm. (2.24-inch) M18 recoilless rifle weighs 44 pounds—almost 20 pounds less than the caliber .50 M3 aircraft gun. The size and weight of a gun can vary greatly for a fixed size of projectile.

Effect of Velocity

Five sizes of caliber .50 gun, all firing or capable of firing the same projectiles, are shown in Figure 1. The 5 guns vary in weight from 21 pounds to 105 pounds—a factor of five. The variation in weight is due in small part to cyclic rate or shot density and in large part to increased muzzle velocity which can be translated to time of flight, which materially influences hit probability because of the effect on fire control.

In Figure 3 is a series of existing 20-mm. guns, all capable of shooting the same projectile, but the heaviest is about four times the weight of the lightest. This heavier weight is the price which must be paid for high velocity and high rate of fire, both of which are very desirable when one is trying to hit a fast-moving target like a modern airplane.

The same general weight ratio holds true for the ammunition which must be carried to feed these guns. The weight increases with power and is not necessarily a function of caliber.

For example, in a series of existing caliber .30 cartridges, the smallest—the carbine cartridge—weighs only 193 grains per round while the largest, which carries the same caliber bullet, weighs more than six times as much, and the energy delivered is far greater.

The weight of armament is therefore much more nearly a function of the power delivered per shot than it is a function of caliber.

We then arrive at the $64 question: "How best can we spend our fund of allowable weight which is limited by the carrying capacity of the airplane?" We can spend this weight with emphasis on large-caliber heavy projectiles to insure great damage to the enemy when we hit him, but we will probably have fewer projectiles with which to insure a hit.

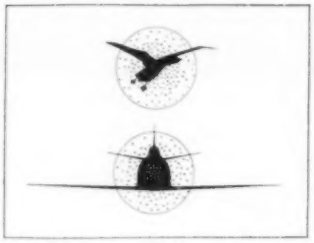


Fig. 4. Shot pattern from a 12-gauge shotgun against a duck target at 40 yards (150 shot in 30-inch circle) compared with pattern from 6 machine guns firing for one second against a plane at 500 yards (120 shots with 8 mils dispersion).

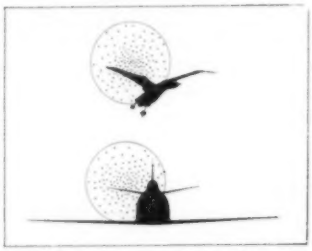


Fig. 5. When the shooter's aim is not so accurate, shotgun and aircraft machine gun patterns still cover vital spots.

Fig. 6. Heavier aircraft guns fire only 20 shots a second, all of which can miss target at same range and dispersion.

We can utilize our available weight in high velocity in order to cut down the distance the enemy can move while the bullet is in flight and thereby improve the chance of a hit; but, again, we must pay for this in the form of fewer rounds available during the time on the target or in lighter weight or lower velocity of projectiles fired.

Light but Fast

Finally, we can use the available weight in relatively light guns firing a vast number of small projectiles, any one of which can insure a kill if a vulnerable area is hit.

Figure 2 presents different gun installations for a 13,500-pound fighter with a 1,200-pound armament limit. From this can be seen the price paid in the adjustment of muzzle velocity, pattern density, and muzzle energy to meet the requirements of individual armament systems.

Let us consider the problem in its simplest terms. Armament of any caliber does no good unless it hits the target, and a modern airplane traveling at high speed is by any standards a difficult target to hit.

The problem is further complicated by the fact that the attacking plane is also traveling at extremely high speed, with the result that the time available to aim and register a hit is very short and the chance for human and mechanical aiming error is obviously great.

Perhaps some idea of the problem might be obtained if one imagined one's self shooting ducks from a fast-moving automobile. Although fire-control devices have been developed to an amazing degree, they are never perfect, and the factor of human error when shooting under these adverse conditions cannot yet be eliminated.

"Ducks and Airplanes"

We have produced a few reasons showing the dissimilarity of elephants and airplanes as targets. Now let us consider a point of similarity of ducks and airplanes as targets.

The duck hunter uses a shotgun rather than a rifle primarily to allow himself some latitude in aiming. His fire control is not perfect. He selects a shot size which will provide a sufficient number of shots within the carrying capacity of the cartridge to provide a lethal distribution in the area covered by the shot spread at a range at which he expects to shoot.

This distribution is called the "pattern," and it is usually adjusted to provide several hits on a bird anywhere within the pattern to insure penetration of a vulnerable area.

Buckshot, for example, cannot be used, as there are only nine shot in the load, and when they reach the target and have spread sufficiently to compensate for aiming error the probability is that they may pass on all sides of the bird without touching it.

On the other hand, there are more than 1,000 No. 10 pellets in a 12-gauge

load, and this vast number will insure more hits than necessary, but the small shot size will not provide killing power enough for a duck.

A Compromise

The average duck shooter therefore makes a compromise using No. 5 or No. 6 shot—small enough to provide lethal distribution but each pellet of which has sufficient killing power when it hits a vital area.

The somewhat idealized pattern of a 12-gauge full-choke gun is shown superimposed on a duck in Figure 4. In comparison is shown the idealized pattern of 6 caliber .50 M3 guns when fired simultaneously for one second at an enemy plane at 500 yards.

These sketches do not allow for aiming error. The probability is that in each case the shooter's aim will not be perfect, and Figure 5 shows the pattern when the aim of the duck shooter and the airman is not quite accurate. If the aim is not too bad, hits will probably take place.

When these are contrasted with the pattern of the slow-firing heavier guns illustrated in Figure 6 where the plane, while still in the pattern, can be missed, the need for a high rate of fire and consequent high pattern density becomes obvious.

Rate Varies Density

Density of shot pattern from automatic guns varies directly as the cyclic rate of the armament installation. When one realizes that the patterns we are discussing are formed over a period of time, the advantage of high rate of fire becomes more apparent.

The shots arrive at the target distance one after another, taking a definite time to fill the pattern area. This third-dimensional aspect is difficult to show in a diagram, but when one considers that both the shooter's aim and the target aircraft are probably moving in relation to one another during this interval, the need for establishing a lethal shot distribution in a short time can be readily visualized.

The price paid for increased lethality of individual rounds, which is particularly needed for structural damage, is decreased probability of hitting because of reduced pattern density. Size and weight of projectiles can be increased as fire-control methods improve.

We trust that the discussion up to this point will not have left an impression of complacency with aircraft guns and ammunition currently in use, despite the fine job that those weapons are doing. The Ordnance Corps and the Air Force are not complacent, nor do they intend to become complacent. It was recognized more than ten years ago that the caliber .50 would some day become obsolescent.

50 Per Cent Faster

The fact that our planes today utilize the same calibers as were used in World War II leads to the conclusion by many uninformed persons that development of aircraft armament has lagged. And this despite the fact that at no increase in weight of gun or ammunition our M3 guns fire fifty per cent faster than the older models and do so with an almost unbelievably high degree of reliability.

Development of new armament during and since the war has been continuous, and although the weapons to be used in the future cannot be revealed at the present time, suffice it to say that they are the result of composite thinking by tactical, technical, and engineering personnel of Ordnance, Air Force, and private industry.

Every aircraft gun and every round of aircraft ammunition fired in anger from U. S. planes—whether Army, Air Force, Navy, or Marine Corps—has up to this time been developed and procured by the Army Ordnance Corps. Ninety-two per cent of guns employed as U. S. aircraft armament during World War II were caliber .50.

Many Guns Made

To date, approximately 61,000 caliber .50 M3 and 1,450,000 caliber .50 M2 aircraft guns have been manufactured by Army Ordnance. In the 20-mm. caliber, production to date includes approximately 135,000 M1 and M2 guns, 38,000 M3 guns, and 12,000 M24 guns.

From 1917 to and including 1949, with the implementation of the Unification Act, the Ordnance Corps enjoyed (the usual but perhaps nondescriptive word) a U. S. monopoly in the field of aircraft guns and ammunition.

That monopoly included the development and procurement of guns, feed mechanisms, ammunition, and links. The integration of those development and procurement functions was by common agreement of the Army, Navy, and Air Force.

Charge Forestalled

Reference to Ordnance Corps monopoly of aircraft gun and ammunition activities invites the charge of failure to make maximum utilization of the ingenuity, inventiveness, and competitive zeal of American industry in the development of aircraft armament. Such a charge is forestalled by appreciation of the type of monopoly involved.

The Ordnance Corps alone in the U. S. has the integrated personnel, facilities, and experience to turn out an aircraft gun-ammunition package; yet to do that job effectively Ordnance requires and uses the personnel, facilities, and experience of universities, research foundations, and manufacturers.

The extent of utilization of those nongovernmental facilities is evident from an analysis of expenditures for research and development during the fiscal year. In the case of the aircraft gun and ammunition projects financed by the Air Force, not less than eighty-five per cent of the funds available will be disbursed by nongovernmental facilities.

Major Contributors

Major contributors to those programs include General Electric, Westinghouse, Ford Motor, Oldsmobile, Pontiac, Armour Research Foundation, Midwest Research Institute, Purdue University, and others, including such old established arms and ammunition companies as Western, Winchester, Remington, and Colt's.

In this field of activity the problems of invention, research, and development, in large measure have been turned over to our civilian scientists and engineers.

It will be noted that manufacturers of motors, both electric and gasoline, play a major rôle in the development of aircraft guns. There are obvious similarities between motors and automatic guns.

The integration of aircraft gun and ammunition development and procurement functions within Army Ordnance over a period of decades resulted in a centralized accumulation of facilities, personnel, and experience required for such activities.

Other Responsibilities

The development and procurement of accessories not considered an integral part of the gun, such as mounts, firing systems, chargers, ammunition boxes, and feed and link chutes are the responsibility of the Air Force and the Navy. Likewise the development and procurement of fire-control equipment have always been responsibilities of the Air Force and the Navy.

During fiscal year 1949 the aircraft gun development program of the Ordnance Corps included calibers .50-inch, .60-inch, 20-mm. (.787-inch), 37-mm. (1.46-inch), 57-mm. (2.24-inch), 65-mm. (2.56-inch), 75-mm. (2.95-inch), and 105-mm. (4.13-inch)—a very broad coverage of calibers, considering the limited funds available during the pre-Korean period.

In the larger sizes, the aircraft gun and ammunition program was paralleled, and in some cases extended, by projects involving rocket-type projectiles, rockets, and guided missiles, again within the limits of funds available.

Automatic 37-mm. and 75-mm. guns of standard type had been produced in quantity by the Ordnance Corps for the Air Force during World War II. It will be recalled that the P-39 (Bell) Aircobra supplied in large numbers to Russia was armed with one 37-mm. and two 20-mm. guns. Perhaps the mixed armament of the P-39 provided Russia with the inspiration for the mixed armament of the MIG-15.

75-mm. Aircraft Guns

B-25 bombers were armed with 75-mm. automatic guns, particularly for Pacific operations during World War II. The low cyclic rate of forty-five rounds a minute—less than one a second—provided inadequate hit probability in return for the weight carried, with the result that the 75's were gradually displaced by twelve caliber .50 machine guns at a weight saving.

With fiscal year 1950, following unification, the Air Force acquired budget responsibility for aircraft-gun and ammunition development activities. Since then the Ordnance Corps has operated in the field of aircraft weapons wholly on the basis of funds and requirements supplied by the Air Force or the Navy. It is not unnatural that progress made in the various types and calibers has been directly proportional to the fiscal support.

The Ordnance Corps has been in the fortunate position of carrying on an extensive program in complete sympathy with the decisions of the Air Force. The reasons behind those decisions are well understood and fully appreciated.

We have emphasized the complete agreement of Ordnance with the Department of Defense aircraft gun-ammunition program. Security restrictions bar us from discussing that program.

Caliber .30 machine guns exclusively were used in U.S. aircraft in World War I. Between wars there was a gradual but almost complete shift from caliber .30 to caliber .50 and 20-mm. During World War II the Air Force used caliber .50 predominantly. The Navy used caliber .50 until a shift to 20-mm. late in the war. The shift started in 1944.

Firepower Increased

During the war we perfected the M3 caliber .50 gun which, at no increase of size or weight, fires at the rate of 1,200 rounds a minute—50 per cent more than the M2. The M3 is living up to the same reliability performance as the M2. One air group in Korea has reported the firing of two million rounds with only seventeen stoppages from all causes!

At the end of World War II we brought out for bomber-turret use the M24, .20-mm. gun which is an electrically fired version of the M3 20-mm. using electric-primed ammunition.

The following descriptions of commercial aircraft gun developments by foreign firms will give some idea of their trend in aircraft gun design:

"Much more interesting than these antiaircraft guns with conventional breech are the novel high-speed aircraft cannon in the prototype development section. They reveal the design principle of the German MG213C (Mauser) machine cannon which was evolved toward the end of the last war but never saw combat. . . . 20-mm. revolver cannon with a rate of fire of 1,600 to 1,800 rounds per minute and a muzzle velocity of 3,600 foot-seconds (1,100 meters per second) . . . 30-mm. revolver cannon with a rate of fire of 1,200 rounds per minutes and a muzzle velocity of 3,610 foot-seconds (1,100 meters per second)."

The competition offered by foreign developers in this field is welcomed.

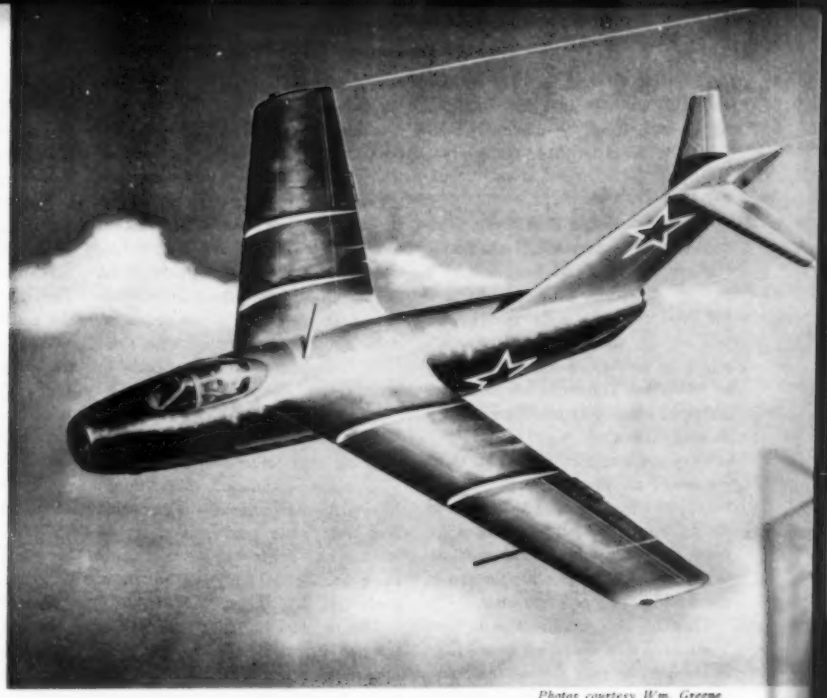
One of the original Mauser models, of which there were not more than ten, was brought to the United States by the Ordnance Corps in 1945, together with key German personnel involved in its development.

Constant Vigilance

This type of constant vigilance over world thinking in armament design is an important part of the Ordnance function. The public can be assured that our planes will continue to be armed with the world's finest matériel utilizing the most progressive ideas available, no matter what the source.

The Ordnance Corps and the Air Force are keenly aware of the present efforts of the aircraft designers throughout the world to make planes less vulnerable to incendiary ammunition. We all recognize that if fuel is rendered invulnerable to ignition by projectiles, larger calibers will come into their own despite the price which must be paid in weight or pattern density.

The Ordnance-Air Force-Industry development programs which have been under way for some time cover this contingency and new, high-cyclic-rate weapons firing powerful high-blast ammunition will be available when required.



The MIG-15 jet fighter plane now being used in large quantities by the Chinese Communists shows there are huge resources behind the Reds in . . .

Photos courtesy Wm. Greene

The War in Korea

By Jerry Greene

NO matter what the diplomats and the politicians may say for one reason or another, a cold, objective analysis of facts available to any one reveals very clearly that the U. S. has been at war with at least a part of the Soviet for more than a year.

The labels attached to the fighting in Korea don't matter. The Korean shooting, the causes therefor, and the situation in China have long been and will continue to be major political issues and probably will be a matter of historical debate for a decade.

Even a brief study of these facts, of which there will be more in a moment, should convince any thinking person of the capability of the one potential enemy of the U. S. and the grave danger shuddering in the skies around the outskirts of America right now.

Take a look at the figures. Today the Soviets have about 7,000 MIG-15 jet fighter planes. The MIG's use a souped-up version of the British Nene jet engine, improved by the German engineers who were picked up just before and after V-E Day.

The U. S. now has, openly demonstrated in Korea, just one jet which can compete with the MIG, and that's the Sabre F-86. To the embarrassment of this country, we have only 800 Sabre jets, and they are scattered from Frankfort to Korea.

"Duck Hunters"

Our other jets, the older and slower jobs, are, of course, very good airplanes for duck hunting, and that's about all they are being used for. There are a good many of them in action in Korea, and they are shooting up a lot of Soviet stuff—but not MIG's.

The Air Force reports that at the end of April it had lost 538 planes in combat in Korea. Sixty-six were shot down in air-to-air combat, 419 fell from antiaircraft fire, and 53 were lost from "other causes." Those planes just didn't come home. At the date of this report,

Mr. Greene, a New York City journalist and military analyst, was a war correspondent with the United States Marines in World War II.

the Air Force claimed 248 MIG's knocked out in combat and admitted 30 of our carefully nurtured F-86 Sabres had been stymied.

Superior Fighter

Extremely reliable information here is that the Soviets have in production—that's production and not design—a fighter plane far superior to the MIG-15. We have some twelve new jets on the line or in design which might be able to handle the MIG-15 or its betters. The aircraft builders are a little cautious in claims these days, in view of Korea.

They are mindful, no doubt, those we talked to, that before the Soviets rolled out the MIG the press agents in the U. S. were blowing the horn for anything that would fly and announcing it was superior to what the rest of the world would or could offer.

They are also mindful that to have 7,000 MIG's in operation now—1,000 of them in or near Korea—the Soviet had to start building that aircraft in 1946. The slide rules just can't cut the margin any closer.

Now if Russia started in 1946 to build in quantity a plane which is the equal to or better than anything the U. S. has ready for combat, the men at the Pentagon wonder, what did she start to build in 1947-48-49-50 and maybe even last year?

It is highly doubtful that the U. S. built 7,000 fighter planes of all types, much less jets, since 1945.

20,000 First-Line Planes

Air Secretary Thomas Finletter recently told Congress that the Communists have 20,000 first-line combat planes and another 20,000 in reserve. The U. S. couldn't match that by counting the Civil Air Patrol, private planes, and the airline capacity.

But the number and quality of aircraft alone are not the key secrets to the danger facing the U. S. The most alarming factor is the ability of the Reds to spare 1,000 MIG's for the Korean area and to keep these planes in operation. That's what's worrying the Pentagon, and that is the sure sign that we are fighting the Soviets and not a batch of erstwhile rice pluckers hauled out of Chinese paddies for practice in power politics.

It was our good fortune back just before and during the early months of World War II, before we went wandering off with the Marines, to be exposed to such men as Lieut. Gen. Levin Campbell and Maj. Gen. G. M. Barnes and the late Maj. Gen. Alexander D. Surles. One of our most informative days was spent on an excursion to Aberdeen Proving Ground with Generals Campbell and Barnes back in early 1942.

Logistics Important

These and other top-flighters in Washington cautioned one thing: "Anybody can write about homesick lads and people getting shot. If you want to find out how this war is going to be won and who is going to win it, study and write logistics."

That became more pertinent when we had to cut down our own intelligence gear from 6,500 pounds to 3,000 pounds for movement to an alleged "forward area" two years later. Marine Corps, that is.

But the very simple look at logistics tells the story of what is going on in Korea, and it is about time the American people took a look, in one man's opinion.

Our casualties are well over 100,000 as announced by the Defense Department. The Defense Department won't say officially, but it is a safe guess we have some 150,000 to 200,000 men in Korea. That, of course, doesn't count the people and ships necessary to get them there.

The Defense Department won't come up with current figures, for what seem to be obvious reasons. But take a scan

at this: In World War II it took 600 tons of supplies a day to support one infantry division in combat.

That was broken down roughly in this manner: The division needed 50 tons of food. It needed 50 tons of clothing and miscellaneous supplies including medical, signal, vehicle. The division—not a motorized one—had to have 50 tons of gas and oil and 450 tons of ammunition.

At the cost of tiresome repetition, let's look at that again. In an attack position, one division needed 600 tons of supplies a day, and it is well known that we have six divisions in Korea. Only God, as far as U. S. reporters are concerned, knows what the rest of the United Nations have in line, but it is not inconsiderable, and the British, Turks, and French have to eat and shoot also.

What it has taken in the way of transport and manpower to get this stuff to Korea the Navy won't say, but it has been considerable. A tanker burns a lot of oil to carry high-octane gas or kerosene from San Francisco to Pusan for a flurry of fighter sweeps to kiss off a few Red locomotives and bridges.

Please keep in mind that this has been going on since June 1950.

The Other Side

Now let's look at the situation from the other side. Obviously the Chinese and the Russians get along in life, battlefront or elsewhere, with somewhat less than the average American expects. We'll take an odds-on bet that not many Russians get letters from home and that most of them couldn't read them if they arrived.

We'll also put up a little wager that 9,321 American mothers would write their Congressmen if they heard their sons were restricted to a diet of vodka and potato soup.

800,000 Troops in Korea

Estimates around Washington are that the Chinese Communists have 800,000 troops in Korea or, if not actually there, close at hand. Looking at the U. S. division supply needs it doesn't take a mental giant to calculate what those Reds have to have to continue as a deadly menace. Supposing there are only 400,000 of them and they only get a pound of rice a day for groceries. Who's carrying all that rice?

But let's get a little more technical. Nobody any more is arguing the point that the Communists have 1,000 MIG-15's in or around Korea. The Chinese are sending as many as 200 in one flight against the U.S.-U.N. forces.

Take the pilots first. The U. S. air people want men who have 1,500 to

2,000 hours in the air to fly Sabre jets in combat. That's probably the big reason our people are knocking off the MIG's at a pretty good rate.

We also have combat pilots in Korea, flying jets, who have logged less than 200 hours and who are doing a whale of a job. But they aren't, as a rule, being exposed to the MIG's.

1,500 Trained Pilots

Now to handle those 1,000 MIG's, the Reds must have at least 1,500 pilots trained in jet fighter operations and willing to shoot it out. This country would demand a larger pilot margin.

It is known by more than a few that at first all the MIG's were run by Soviet fliers, but recently the Chinese have been swishing the crates and asking for suicide. And that means the Chinese pilots have been learning to fly jets for well over a year.

Any U. S. air general will tell anybody he'd like to have a pilot in training for at least two years before committing him to combat, and particularly in this new hot stuff.

Certainly, therefore, somebody is running around helping the Chinese Communists in their fight for freedom from Koreans who never liked them anyhow. In the early days of World War II it was the American General Claire Chennault who set up the Flying Tigers to help the Chinese operate against the Japs.

Not even Joe Stalin could be stupid enough to believe his own propaganda that the Chinese Reds have progressed so far in recent months that they could build jet fighters by the thousands and spend two years teaching "Chinese patriots" to fly them.

Oil for China

Comes now another point. So far as is known publicly, there isn't much known around here about any big Chinese oil fields or refineries. Didn't somebody write a book on how somebody picked up a piece of change by supplying "Oil for the Lamps of China"? And there has been much public talk in Congress about oil being shipped to China since the Korean war started.

Most of this shipped-in oil was supposed to have gone to Shanghai. Well, it's a long way from Shanghai to Korea, and the railroad service isn't quite as efficient as in the U. S.

We don't have the answers to these questions but we wish we did, for the American public ought to have them. But the answers seem self-evident when you get a look at the situation, keeping in mind that the Reds have only one railroad across Siberia. There is an airlift somewhere which almost puts our Berlin job to shame.

Think back to the size of that air force of 1,000 MIG's—and that doesn't include a few bombers the Reds have squatting around here and there.

9,500,000 Gallons

To maintain those MIG's, even at the present rate of fighting where there are a few flurries per day, takes 9,500,000 gallons of fuel a month. That amount of fuel weighs 33,000 tons. It doesn't matter whether the Reds burn 100-octane or lighter fluid, the slide rule comes out about the same.

If there are no oil wells and no refineries in China, where are the Communists getting this fuel and who is carrying it for them?

That's only one point of the picture. There must be, and our intelligence experts know it, some ten to twelve airstrips and four or five major bases with repair facilities not far from the Yalu River. It would take this many to handle the planes known to be on hand.

It ridicules credulity to consider the idea that Chinese, who less than six years ago were making bayonets by hand, are now manning jet air bases and speeding up the repair of hot-rod planes which have limped back after a sonic-speed fight with U. S. aircraft at an altitude of 50,000 feet.

Of course there are such matters as oxygen tanks and masks and parachutes and pop-out seats for pilots which the sons of Confucius have been making for years!

How Did It Happen?

The U. S. people know what the enemy has. The big worry is, how in the name of logistics did the Reds get the quantity there, how is the stuff being maintained, and who can spare the 40,000 trained technicians and specialists needed to keep those MIG's not so very far from U. S. territory?

Writing on "Russia's Jet Aircraft" in the January-February 1951 issue of ORDNANCE, William Green, well-known British aviation authority, and Roy Cross made the following comment:

"The low-velocity, high-capacity gun, typified by the German 30-mm. Mk-108, has been deemed by some to be superior to the high-velocity weapon of smaller bore, and the Russians are obviously to be numbered among the 30-mm. gun's adherents as their latest fighters all use 30-mm. or 37-mm. weapons with supplementary 20-mm. Sh-VAK cannon.

"The latest Russian aircraft guns are believed to follow the principle of the 30-mm. Mauser MG-213, having a higher velocity and a flatter trajectory—the muzzle velocity being about 2,000 feet a second—with rates of fire up to 1,000 rounds a minute. Both the MIG-15 and La-17 carry one such gun in addition to one or two 20-mm. Sh-VAK type. Guns are fitted either side of the nose-wheel housing and, in the case of the MIG-15, protrude somewhat from their troughs.

"The power plants of these new fighters are believed to be one of a new series of centrifugal compressor units developed by M. B. Chelomey and A. D. Charomski from the British Rolls-Royce Nene."

The OAC is the directing agency of the Ordnance Corps' new integrated ammunition program

by

Brig. Gen. Joel G. Holmes

Commanding the Ordnance Ammunition Center, Joliet, Ill.

In an Ordnance Ammuntion Center loading plant women inspectors use mirrors to help check the proper arming function of fuze bodies.

The Ordnance Ammunition Center

THE Ordnance Ammunition Center, located ten miles south of Joliet, Ill., is the headquarters of the Army's ammunition production program.

Its business is the mass production of standard Army ammunition larger than that used in small arms. The Center directs nearly all U. S. production of artillery ammunition, rockets, aërial bombs, land mines, hand and rifle grenades, and pyrotechnics.

This was a $2.3 billion program for the fiscal year 1952—representing 10.4 per cent of the total Army budget and 3.7 per cent of the total defense budget.

Development Traced

Because of its magnitude and its resultant requirement on the taxpayers, and because a service vital to the security of the United States and the free world is being rendered, the ammunition program and its progress should interest all Americans. Those who are especially concerned with ordnance may find it interesting to trace the development and learn the current operation of the Ordnance Ammunition Center (OAC).

Today, OAC is the national business administration, production and procurement direction center of the Ordnance ammunition program. It has responsibility for the command and supervision of twenty-four Ordnance installations located in seventeen States. These comprise eleven shell- and bomb-loading plants; twelve explosives, propellant, and chemical manufacturing works; and one ammunition proving ground.

Directs Procurement

It directs and coördinates the nationwide procurement of metal components

The final step in the ammunition process: workers pack finished 105-mm. shells into fiber containers at an Ordnance Ammunition Center loading plant.

The machine shown above is a binitrating device used in the manufacture of TNT in one of the OAC's explosive plants.

Other plants make rocket powder which is slit into strips and made into "carpet rolls" as shown above for extrusion later.

for the ammunition which these loading plants produce. Further, it controls ammunition production facilities at four additional Ordnance Corps installations and supervises certain ammunition-processing work (mostly renovation and demilitarization) at twenty Ordnance Corps field service depots.

Considering OAC as an industrial corporation, its 24 installations represent a capital investment of more than $1.5 billion, and more than 90,000 workers are employed at these facilities. Parts and subassemblies are purchased from some 1,600 prime suppliers, who in turn are serviced by probably 6,000 subcontractors.

In the past year the purchased components amounted to $1.5 billion, and the total worth of the goods produced (or on order) was about $2.5 billion.

Huge Enterprise

A plant expansion and modernization program now nearing completion will cost nearly a half-billion dollars. Few private enterprises in the United States operate on such a tremendous scale.

Basically, the Ordnance Ammunition Center represents the answer to a need—the need for a centralized, integrated ammunition production program through which the Ordnance Corps could meet two of the requirements dictated by the current conflict and world-wide tension:

Two Requirements

1. To assure safe stock levels and fill the ammunition pipelines to Korea and our NATO allies; and

2. To establish a sound, adequate "industrial base" for ammunition production from which we could quickly expand, if necessary, to full production.

The experience gained in World War II and the thorough study, planning, and preparing that was done in the 1946-1950 period made it possible to meet these needs.

Like all new programs, this one has not functioned perfectly. As usual, "bugs" appeared when the stresses and strains of initial operation were exerted. But after twenty months of experience, it is evident that the basic OAC concept—centralization and integration of procurement, production, inspection, and business administration—is sound.

It has been in a large measure responsible for the reasonable degree of success with which the ammunition production program has met the demands of the past twenty months. As time goes on, this integrated and centralized program will enable the Ordnance Corps to produce more ammunition at lower cost than could be produced under procedures used earlier.

History of OAC

How did the Ordnance Ammunition Center come to exist? Mostly, it evolved from the former Office of the Field Director of Ammunition Plants, and the story of that evolution is World War II and postwar history.

The outbreak of World War II found the United States unprepared for the mass production of ammunition. As late as 1940, both smokeless-powder capacity and TNT capacity were only about 100,000 pounds a day, and practically no facilities were available for the mass loading and assembly of heavy ammunition.

In the following 26 months, however, under the pressure of all-out war and a national policy of full military production, the Government built 73 plants at a cost of about $3 billion. Twelve of these were for small-arms ammunition.

Sixty-one were to produce military chemicals, propellent powders, high explosives, and demolition blocks and to load shells, bombs, rockets, grenades, and land mines. These plants were operated for the Government by private companies under cost-plus-fixed-fee contracts.

Handling Improved

As the operation of these sixty-one plants got under way, it was indicated that the handling of administrative, legal, production-control, and maintenance problems would be improved by centralizing the administration of the contracts in a new agency, separated from the Washington headquarters of the War Department.

In August 1942 the Office of the Field Director of Ammunition Plants (OFDAP) was established in St. Louis. Throughout the war, OFDAP directed and supervised the operations of the sixty-one plants.

As time went on, the scope of OFDAP's authority and activity was enlarged to include inspection, packaging, scheduling of loading, etc. However, the procurement and inspection of metal parts was not administered by OFDAP but continued to be handled by Washington through the various Ordnance districts.

Almost simultaneously with V-J Day, the tremendous outpouring of ammunition from the OFDAP plants was halted. Shutdown and stand-by procedures were started in September 1945 and continued into 1946.

In December 1945, OFDAP headquarters were moved from St. Louis to Joliet and relocated on the grounds of Joliet Arsenal, one of its installations.

In the 1946-1950 period, the activities of OFDAP consisted mainly of:

1. Maintaining the stand-by industrial facilities. These decreased in number from forty-one in 1946 to twenty-seven in 1950, as unneeded facilities were sold, leased, dismantled, or transferred to the custody of other Government agencies. This reduction was in accordance with the demobilization plan prepared during the war which called for retention of about forty per cent of the peak World War II ammunition production capacity, diversified so as to produce a balanced variety of ammunition items.

2. Renovation, demilitarization, and new production of ammunition. The last was limited in volume to the excess parts on hand. Renovation and demilitarization activities (which had been assigned to OFDAP in 1946) were substantial and aided materially in keeping finished ammunition stocks up to safe and adequate levels.

Brass and copper alloys recovered in the breakdown of unserviceable ammunition also were stock-piled and have been used to good advantage in the present period.

3. From 1946 to 1950, a total of sixteen OFDAP installations participated in the production of crystalline ammonium-nitrate fertilizers which were shipped to impoverished European and Asiatic countries. These sixteen OFDAP facilities (some of which were in production for only a part of this period) were operated by contractors.

4. In 1948 OFDAP was assigned responsibility for the preservation, storage, and maintenance of valuable machine tools owned by the armed services and scattered throughout the country. Some 13,000 of these were shipped to 12 OFDAP installations, inspected, preserved, stored, and maintained by OFDAP and special-contractor personnel.

Having this equipment available during the past two years has contributed immensely to the progress of the current program.

Another Vital Function

One other vital function was performed by OFDAP during the 1946-1950 period—industrial-mobilization planning. Under this program, considerable effort was spent trying to capitalize upon the lessons of World War II in the technical, production, and administrative fields, and a number of important measures were taken.

One of the measures was obtaining the interest and assistance of those industrial concerns which had acquired ammunition-production experience and know-how. More than twenty of the private firms which had operated OFDAP plants in World War II joined in studying and improving management procedures of contractor-operated plants and in preparing improved forms of cost-plus-fixed-fee contracts.

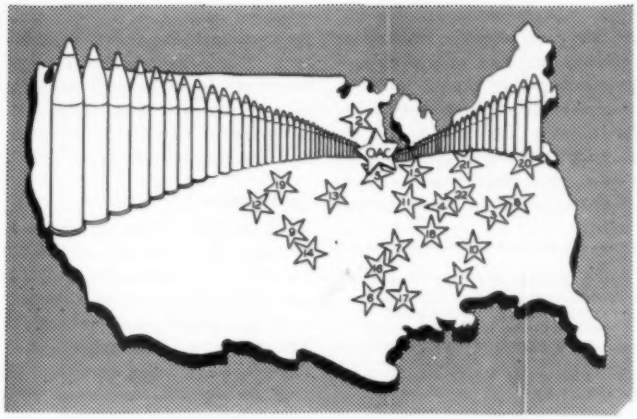
About a dozen of these firms agreed, on a $12,000-maximum-expense-reimbursement basis (two submitted no bills, and most of the others spent more than $12,000) to inspect the stand-by facilities at various installations, make recommendations for improvements, and prepare plans for the emergency reactivation of certain facilities. In some cases, tentative proposals were obtained, setting forth the steps to be taken in future reactivation of these facilities.

Far-Reaching Conclusion

In this management planning, the most far-reaching conclusion arrived at in the Ordnance-Industry discussions was the necessity of integrating the procurement of inert components into the OFDAP ammunition-production program and centralizing the complete production responsibility in this single agency.

This conclusion was embodied in the Plan for Industrial Mobilization furnished by OFDAP to the Chief of Ordnance (then Maj. Gen. E. S. Hughes) in July 1949. When the plan was acted upon in the fall of 1950, additional evidence in support of this conclusion was furnished to the Chief of Ordnance (Maj. Gen. E. L. Ford), and when the Ordnance Ammunition Center succeeded OFDAP on November 17, 1950, the procurement function was assigned to OAC.

June 1950 found OFDAP in control of twenty-seven installations. In the first two months following the Korean eruption, ammunition requirements were established in Washington, procurement activities expanded at Picatinny Arsenal, and loading requirements were received at OFDAP head-



The location of Ordnance Ammunition Center installations

Propellant and Explosives Works: (1) Alabama Ordnance Works, Sylacauga, Ala.; (2) Badger Ordnance Works, Baraboo, Wis.; (3) Holston Ordnance Works, Kingsport, Tenn.; (4) Indiana Arsenal, Charlestown, Ind.; (5) Joliet Arsenal, Kankakee Unit, Joliet, Ill.; (6) Longhorn Ordnance Works, Marshall, Tex.; (7) Maumelle Ordnance Works, Little Rock, Ark.; (8) Radford Arsenal, Radford, Va.; (9) Sunflower Ordnance Works, Lawrence, Kans.; (10) Volunteer Ordnance Works, Chattanooga, Tenn.; (11) Wabash River Ordnance Works, Newport, Ind.

Loading and Assembly Plants: (12) Cornhusker Ordnance Plant, Grand Island, Nebr.; (13) Iowa Ordnance Plant, Burlington, Iowa; (5) Joliet Arsenal, Elwood Unit, Joliet, Ill.; (14) Kansas Ordnance Plant, Parsons, Kans.; (15) Kingsbury Ordnance Plant, LaPorte, Ind.; (16) Lone Star Ordnance Plant, Texarkana, Tex.; (17) Louisiana Ordnance Plant, Shreveport, La.; (18) Milan Arsenal, Milan, Tenn.; (19) Nebraska Ordnance Plant, Wahoo, Nebr.; (20) Ordnance Assembly Plant, Edgewood, Md.; (21) Ravenna Arsenal, Apco, Ohio.

Proving Ground: (22) Jefferson Proving Ground, Madison, Ind.

quarters in Joliet. Funds were made available and the work of reactivating certain plants and works got under way.

In November 1950, when OFDAP became the Ordnance Ammunition Center, procurement machinery was set up. The flow of metal components to the loading plants started in the early months of 1951. An Ordnance Ammunition Center Small Business Office was established which has helped many component manufacturers to participate in the ammunition program.

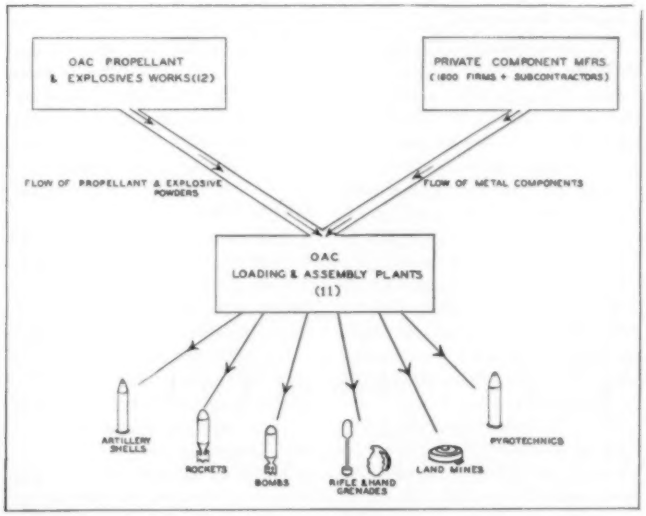


Chart shows the flow of propellants, explosives, and components to Ordnance Ammunition Center loading and assembly plants and thence into finished products.

Decisions Made

During these and the following months the Ordnance Ammunition Center decided which loading plants and explosive works were needed to meet the expanding ammunition requirements. Rehabilitation contracts, most of them based on the postwar surveys, were awarded by the Corps of Engineers, and the reconditioning work got under way. Proposals and estimates were obtained from the previously selected contractors, and new cost-plus-fixed-fee operations contracts were negotiated.

Today the program is well under way. About forty per cent of the retained World War II production facilities have been rehabilitated and are now operating at partial capacity. Another thirty per cent are being reconditioned and will be operating (also at partial rates) by the end of this year.

An additional fifteen per cent are scheduled for rehabilitation and use by the summer of 1953, and the remaining fifteen per cent are scheduled to remain in stand-by. Currently, about one hundred different end items of finished ammunition are being produced.

Of the twenty-three production facilities still controlled by OAC, all eleven loading and assembly plants are now operating. Nine of the twelve explosives and propellant works are in production, and another is being rehabilitated. At most loading plants, only one shift of workers is employed.

All but two of the twenty facilities now producing are operated by contractors. The total current value of their cost-plus-fixed-fee contracts is about $1.2 billion.

The two Government-operated production facilities are the Ordnance Assembly Plant, which produces chemical ammunition; and the Elwood Unit of Joliet Arsenal, which loads shells, bombs, and components. The former is Government-operated largely because of its geographical and technical connection with the Army Chemical Center in Maryland.

The Elwood Unit remains in Government operation for several reasons. One is to retain a permanent installation where a valuable and essential nucleus of trained, permanent Ordnance personnel can be utilized to advantage on a continuous basis. Another is to make available a yardstick by which productivity and costs at contractor-operated plants can be measured. A third reason is to have loading facilities available so that new production-engineering improvements can be tried and perfected.

Although the complete operating procedures of the Ordnance Ammunition Center are necessarily complex, the basic operating scheme is simple, involving three principal functions—procurement, production, and inspection.

Metal Components

Metal components are procured from private firms holding definitive contracts. Explosives and propellants are manufactured in OAC's contractor-operated chemical works.

The metal components and the explosives and propellants are brought together in OAC's loading and assembly plants (also contractor-operated), where the finished ammunition is turned out.

Product inspections are made during the procurement and production phases, and completed items are inspected and tested for final acceptance. In essence, this is the OAC operation.

A fuller and perhaps more useful understanding of the functioning of the Center might be conveyed by tracing the course of a simplified but typical ammunition order. The date is January 1, 1952. OAC has just received from the Office of the Chief of Ordnance a "procurement program requirement"—an order—for an additional two million rounds of high-explosive ammunition for the 105-mm. howitzer. The schedule calls for delivery of 150,000 shell a month, starting in January 1953, to provide the required 10-to-12-month "lead time" (which will be explained in the following paragraphs).

List Prepared

OAC's Material Division prepares a listing of the sixteen individual and matched-set components of a 105-mm. shell, which includes a shell assembly, cartridge case, primer assembly, fuze assembly, etc. Two million each of these parts will be needed to fill this order—a total of thirty-two million separate parts.

The component list is checked against present stocks and quantities already on procurement, and a new procurement schedule is established. It is decided that present stocks and components now on order are required for prior orders, and OAC will therefore have to procure all the thirty-two million parts required.

"It is believed that the ammunition program is now on a sound footing. Every possible effort is being made to keep our troops adequately supplied with ammunition, to fill the pipelines to Korea and to our allies, and to increase U.S. stock piles."

A check of the production of present suppliers and of OAC's future production requirements indicates that supplements to present component contracts could not meet delivery requirements and that our industrial base should be expanded by procuring the required thirty-two million parts from new suppliers.

Proposals Requested

OAC then asks each of the fourteen Ordnance districts to obtain proposals from its area companies on furnishing the various procurable components needed and to get these proposals back to OAC within six weeks.

Each district contacts its prospective manufacturers and within thirty days receives from interested firms their fixed-price proposals and facilities costs (if any). Each district studies the proposals received and forwards them to OAC, usually with recommendations based on current and accurate knowledge of the companies concerned. It is now March 1st.

The bids received from all districts are then studied by OAC. Certain districts may be requested to furnish additional information. After full consideration, the Awards Board of OAC determines which districts have submitted the lowest and most dependable bids on the various parts required. Then the selected districts are requested to negotiate and execute contracts with the most suitable firms in accordance with stipulations as to unit price, equipment cost, delivery schedules, etc.

An Example

Let us assume that the Cleveland Ordnance District is made responsible for furnishing a million fuzes on this order. The district then negotiates and executes a definitive contract with the Jones Company to supply these million fuzes. The date is now May 1st.

In its proposal Jones stated they would need certain machine tools. Since this equipment is not available from the Ordnance Corps industrial reserve, funds are made available to Jones to purchase this equipment (which becomes Government property). So Jones follows up its own leads, or contracts furnished by the district or OAC, and buys the tools.

Also, Jones needs help in getting steel and brass. The company submits a list of the materials needed and an "application for allotment of controlled materials" to the Cleveland Ordnance District, which screens and forwards them to the Ordnance Ammunition Center.

If they are approved, OAC issues to the Jones Company, through the Cleveland District, an "allotment of controlled materials" which Jones certifies to the different mills. But perhaps the mills will not accept Jones' order, even with certification. Then Jones comes back to OAC for priority assistance.

Priority Given

With its nationwide contacts, OAC may be able to locate the materials without priority. If not, OAC then certifies to the National Production Authority that the Jones Company needs certain quantities of steel and brass at given rates to produce 75,000 fuzes a month. NPA then directs certain mills to accept Jones' orders and furnish the metals required.

While this "materials hunt" has been going on, Jones has been tooling up, putting out subcontracts, familiarizing personnel with the new job, hiring new

employees, etc. It is now July 15th. Initial production is ready to get under way. What Jones is striving for is to get a pilot lot of perhaps a hundred fuzes produced by September 1st.

Inspection Group

Here the Ordnance Corps' inspection group enters the picture. Their job is to see that the Government gets exactly what it has ordered from the Jones Company. The Cleveland Ordnance District places three inspectors—trained Civil Service employees—in the Jones plant to inspect the fuzes as they come off the lines.

The plant-inspection procedures have been established by OAC to insure nationwide uniformity of fuzes. These are followed by the district inspectors.

On October 1st the pilot lot of one hundred fuzes is turned out and shipped, let us say, to the OAC pilot-lot laboratory in Joliet. (Pilot-lot inspections are also done at Picatinny and Frankford Arsenals.)

Government engineers and technicians at the Ordnance Ammunition Center check them for conformance with the drawings and specifications. These fuzes undergo tests that accurately determine their physical, metallurgical, tensile, functional, and other characteristics.

This laboratory inspection may bring out defects which the Jones Company will have to correct. However, let us assume that this pilot lot of fuzes tests satisfactorily. The Jones Company is advised of this through the Cleveland District.

Machinery Started

The date is October 15th, and Jones sets in motion its full production machinery. In that month, 5,000 fuzes are turned out. By December, the schedule of 75,000 fuzes is met, and the Jones Company is performing in accordance with its contract.

This, in simplified form, is how the Ordnance Ammunition Center's procurement machinery works. Each of the twenty companies supplying the thirty-two million metal parts for this typical order goes through substantially the same procedure in getting into production.

With these twenty companies all in production let us now follow the thirty-two million parts from manufacturers' assembly lines to complete rounds of ammunition. Here OAC's twelve explosives and propellant works and eleven loading and assembly plants come into the picture. All the production work at these twenty-three facilities is directed by OAC's Manufacturing Division.

The explosives and propellant works are geared to component production. Over-all requirements for finished ammunition and the resulting requirements for metal components, propellants, and explosives are constantly under study by OAC. With these factors in mind, periodic determinations are made of the requirements for explosive and propellant production. Based on these determinations, production schedules are established about twelve months in advance, and these materials are shipped into the loading and assembly plants as needed.

In deciding back in January where these two million 105-mm. shell should be assembled and loaded, OAC had examined the advance schedules of the eleven loading plants, especially the four plants where 105-mm. shells were scheduled for December production.

It was decided then, and it is confirmed now, to have 75,000 additional shell per month loaded and assembled at the Kansas Ordnance Plant and the other 75,000 per month at the Elwood Unit of Joliet Arsenal. This decision is based on many factors, including the ratio of current production to capacity at the various plants, labor supply, proximity of the plants to the suppliers involved, etc.

At the Kansas and Elwood plants the metal parts from the twenty manufacturers are assembled and loaded, using TNT which perhaps has come from OAC's Kankakee Works in Joliet and propellent powder which may have been made at OAC's Sunflower Ordnance Works in Lawrence, Kans. Beginning in January 1953, Kansas and Elwood will be turning out 150,000 shell a month to fill this typical order.

OAC's Inspection Division also has a large rôle in this manufacturing phase. Government inspection personnel are stationed at each of the explosives and propellant works. Following OAC procedures, they scrupulously check the ingredients, methods, and final products.

Operations Checked

Similarly, Civil Service employees on the commanding officer's staff at each OAC loading plant inspect the loading and assembly operations as well as the finished products. Perhaps one out of every 100 of the 150,000 completed shells being turned out each month by Kansas and Elwood to fill this order is shipped to OAC's Jefferson Proving Ground for ballistics testing.

Tracing the course of this typical order for two million shells has covered briefly the principal functions and typical procedures of three Ordnance Ammunition Center operating divisions—Material, Manufacturing, and Inspection.

The fourth operating division of OAC—Safety—is also very important. Like Inspection, it covers the entire OAC organization, and its activities are largely responsible for the Center's notable safety record.

It is believed that the ammunition program is now on a sound footing. Every possible effort is being made to keep our troops adequately supplied with ammunition, to fill the pipelines to Korea and to our allies, and to increase U. S. stock piles.

Adverse Factors

This has been accomplished despite several adverse factors, the most hampering being (1) a national policy against disturbing the dominantly civilian economy of the U. S., and (2) shortages of machine tools and special-purpose equipment needed in component manufacture. The steel strike also set back the ammunition program.

However, Ordnance ammunition is flowing today in substantial quantities. If the signal for full production should be received now, it is believed that the challenge could be well met and our obligations to the combat forces and the Nation well fulfilled.

Through five decades

Fifty Years of Arms Development

The United States Ordnance Company's Record of Service to the Nation

by

Dr. John J. O'Connor

How a small firm was of large assistance to the country in peace and war

ONE year after Theodore Roosevelt assumed the presidency, the United States Ordnance Company was incorporated. It has the unique distinction of having been directed by one man since its foundation and of having dealt exclusively with our own military and naval ordnance establishments.

Caribbean Supremacy

In August 1902, national attention was focused on our newly acquired supremacy in the Caribbean and on a choice of routes, Nicaraguan or Panamanian, for a new canal. An energetic reform movement sought to eliminate the evils, while retaining the advantages, of large-scale enterprises.

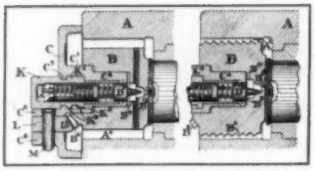
While these lively international and domestic issues were being debated, Abner Y. Leech, Jr., and his associates set about to discover how the newly organized United States Ordnance Company might best serve the national defense of the country. Although the period following the Spanish-American War was not distinguished by any realistic effort to develop a military and naval program commensurate with our rapidly increasing wealth and industrial power, the new company succeeded almost at once in securing contracts with the Navy's Bureau of Ordnance and the Ordnance Department of the Army.

First Assignment

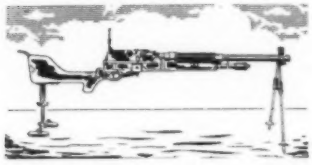
The company's first assignment was received from Rear Adm. Charles O'Neill, Chief of the Navy Bureau of Ordnance, on September 16, 1902. It covered the use of the Tasker continuous-pull firing lock for naval landing guns. A second Navy contract was awarded the company as the result of a successful test at the Indian Head Proving Ground of the Hotchkiss semiautomatic gun for secondary-battery use.

In those long-ago days, competence was recognized, fostered, and encouraged by Army and Navy Ordnance. It seemed obvious to the military and naval leaders of that era that any technological improvement of existing American ordnance, or the introduction into our armed forces of new and superior weapons, was a precious asset that would serve to augment and strengthen the Nation's ability to safeguard its rights, interests, and possessions.

Dr. O'Connor, author and educator, is a member of the editorial staff of ORDNANCE magazine, Washington, D. C.



Above, patent drawing of the Tasker eccentric-plug breech device. Below, the cal. .30 automatic rifle, Model 1909.



To the dedicated men who occupied small offices in the State, War, and Navy Department building in Washington it made little difference whether a new design or invention came from within or outside the services. Abner Leech's fledgling company was therefore regarded as an ally and associate, rather than a rival and competitor, of governmental agencies.

This friendly, open-minded, and progressive spirit nourished incentive. It provided a climate of trust and confidence in which new ordnance ideas could germinate and, in due time, be translated into practical achievements of a high order.

The Tasker Device

Thus the U. S. Ordnance Company conceived, designed, and developed the Tasker eccentric-plug breech mechanism with the complete coöperation of then Brig. Gen. William Crozier, Chief of Ordnance, and then Capts. C. C. Williams and E. B. Babbitt of Army Ordnance.

A test center or proving ground was the final arbiter of rival claims by private firms and Government arsenals. Tests were made, results were tabulated, a verdict was rendered, and con-

tracts were either granted or withheld.

The report of the Chief of Ordnance for 1904 records that "the board is of the opinion that the United States Ordnance Company's breech mechanism, Tasker design, possesses on the whole marked advantages over those tested herewith and is suitable for adoption in the service."

Mechanism Standardized

The successful weapon was referred to in Army manuals as a "3-inch gun, Model of 1902, experimental Tasker breech mechanism." The Tasker invention, comprising an eccentric plug, a rolling extractor, and a continuous-pull firing mechanism, was standardized for field, siege, and coast-defense guns of the Army. It was later adopted by our Navy for 3-inch and 4-inch high-power guns.

The company next introduced into our armed forces the W-C and W-L major and minor caliber base-percussion fuzes.

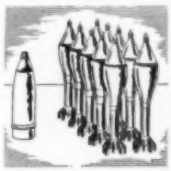
In addition to its own high quality accomplishments, the Leech company made available to our armed forces some of the best ordnance developed in European countries. Early in 1908, for example, the company submitted to General Crozier, then the Army's Chief of Ordnance, an automatic rifle, known as the Benét-Mercié gun. This weapon was carefully tested at Springfield, Mass., and at the School of Musketry in Monterey, Calif.

Rifle Adopted

These tests were successful, and the rifle was subsequently adopted by our Army and Navy. It was thereafter referred to as "United States Automatic Rifle, Model of 1909." The Benét-Mercié piece was the standard Army-Navy machine gun for about eight years and was the forerunner of the now famous Browning automatic rifle.

In 1911 the Navy adopted an electric-percussion firing mechanism for 12- and 14-inch guns which contained, as one element, the Tasker percussion firing lock.

After the untimely death of its well-known and highly esteemed ordnance engineer, Vernon Compton Tasker, the company secured the services of Dorsey Frost Asbury. This capable young engineer was the coinventor, with then Lieut. Comdr. George Leonard Smith, of the standard breech mechanism for large-caliber Navy guns, and he continued to contribute important improvements as engineer of the company.

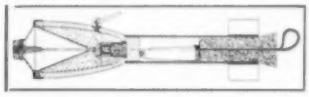


Energa grenades, right.

One of these outstanding improvements was the Asbury counterbalance for siege guns and howitzers which maintains the breech closure in balance at all angles of fire.

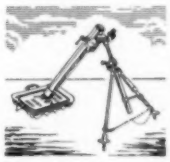
A novel and efficient powder tank was developed by the company in 1917 and supplied to the Navy for use with large-caliber guns.

In 1928 the company submitted to Maj. Gen. C. C. Williams, then Chief of Ordnance, the 81-mm. Brandt mortar. It was successfully tested at Aberdeen Proving Ground, Fort Benning, and Fort Bragg and was adopted for service use.



The Mohaupt hollow-charge projectile.

This mortar and its companion piece, the 60-mm. mortar, proved of inestimable value to the Nation's armed forces during World War II.



The Brandt mortar.

In July 1940, the company brought to the attention of Maj. Gen. C. M. Wesson, Chief of Ordnance, the Mohaupt hollow-charge projectile. The first conference was attended by General Wesson and the following officers of his staff: Brig. Gens. C. T. Harris and Earl McFarland; Cols. H. C. Minton, Keith Adamson, Paul Delalande, and Mr. Leech.

The September-October 1944 issue of this magazine carried a brief account of the general disbelief of the Ordnance Department's technical staff as to the claims made for the new projectile.

Nevertheless, with the hearty interest and complete coöperation of those outstanding Ordnance officers, Brig. Gen. Richard H. Somers, Brig. Gen. John Rose, and Colonel Adamson, and the valuable technical assistance of Henry Mohaupt, Colonel Delalande, and Mr. Leech, a series of remarkable tests were conducted at Aberdeen Proving Ground with rifle grenades, a 2.36-inch warhead (later used in bazooka rockets), artillery projectiles, bombs, and static charges.

Projectile Standardized

As a result of these convincing demonstrations, the Mohaupt projectile was standardized, and a manufacturing license was negotiated with the Ordnance Department.

There is no doubt that the Mohaupt device was the first hollow-charge projectile to be fired from a weapon in the United States. Full credit should be accorded Mr. Mohaupt, a young Swiss engineer who later served in our Army and is now a highly esteemed American citizen.

A recent contribution of the company to national defense is the remarkable Energa rifle grenade, described by Maj. George Fielding Eliot in the July-August 1951 issue of ORDNANCE. It was designed by Edgar William Brandt, inventor of the famous Brandt mortars. This outstanding projectile was successfully tested by the Equipment Board of the U. S. Marine Corps, with the help of Colonel Delalande, technical assistant to Mr. Brandt and Mr. Leech, and was adopted for use.

Safeguard Small Firms

Mere bigness is no guarantee of ordnance superiority. If the ordnance progress of the past fifty years is to be maintained during the coming half century, small private firms should at least be safeguarded against the threat of annihilation by the sheer overpowering size, mass, and number of Government establishments.

In a world of Goliaths, small research and experimental niches should be reserved for such Davids as the United States Ordnance Company.

Month by Month: Highlights of the National Defense

Manpower Shortage

Trained technical manpower is a priceless asset. It should be utilized to the fullest possible extent, particularly as the supply of such manpower today is limited. Indeed, there is a manpower shortage in many fields. We need more engineers, for example, more pilots, more tankers.

> *Yet there are many indications that our armed services are discarding men at the precise moment when they may be attaining their maximum usefulness to the services and to the nation which developed and trained them.*

A Senate subcommittee has charged that the armed services are wasting manpower by assigning five men to a task which could be performed by one.

It is also alleged that the new Reserve Act, passed in the closing hours of the last session of Congress, makes provision for names on mailing lists but not for active, organized training units ready to fight.

Perhaps the most glaring example of a lack of realism in dealing with human resources is an Army plan, under consideration for nearly a year, to order the retirement of 900 colonels whose cases came under the provisions of the 1947 Officers' Personnel Act which makes it mandatory that colonels who have been five years in that grade and have more than 30 years of service must retire.

> *According to one news report, the President may be requested to set up a board to review the retirement of these colonels and thus prepare the way for the issuance of an Executive order which might authorize the extension of the active service of possibly fifty per cent of them.*

The same manpower waste is evident in the statutory retirement of general officers, who are promptly hired by civilian industry, and in the rejection of various officers who have not been allowed to volunteer for active duty either because they were a month too old for the grade stipulation in the job to be filled or because some minor physical defect, which would not bar their employment by private industry, indicated that they might never become Olympic decathalon champions.

The Senate armed services preparedness investigating subcommittee stated that it cannot:

1. Consider an organization efficient when it requires 1,600 men, plus a supply line too long to be estimated, to put 75 single-seat aircraft in the air.
2. Consider a training base efficient when it requires one man to feed, house, and train 2½ men.
3. Consider a ship efficiently run when it is manned by 3½ times the number of seamen required to conduct a similar operation in private commerce.
4. Consider a battalion to be at high-peak efficiency when more than one-fourth of its personnel find combating the enemy a secondary task.

The new Reserve Act has been criticized because the coexistence of two land and air Reserves (the National Guard and the Army-Navy-Air Force Reserve) is an anachronism, because the Guard, while theoretically merged with the Reserve, still retains its dual State-Federal status and its peculiar and privileged autonomy.

The available manpower evidence points to the need for a more realistic national policy in the utilization and conservation of technical skills.

Offshore Procurement

Ambassador William H. Draper, Jr., United States special representative in Europe, has announced that contracts for the production in Europe of military equipment to arm the forces of the North Atlantic Treaty Organization amounted to $684,000,000 during the past fiscal year.

Mr. Draper expressed the hope that these agreements, known as offshore procurement contracts, since they were made with concerns outside the United States, would "contribute materially to the economic well-being of Western Europe during the coming year, both by increasing employment and by making dollars available for imports needed for defense production and for the civilian economy in the various countries."

> *Army procurement orders totaled more than $400,000,000, largely for ammunition, explosives, electronic and engineering equipment, and a few special transport vehicles.*

Our Navy contracted for about $175,000,000 in auxiliary combat ships and other naval requirements. The remainder of the contracts were placed by our Air Force for a total of about $100,000,000.

Government approval in principle was given a plan drafted by NATO for using American funds to help expand the production of military aircraft in Europe.

Under the scheme, European plane makers will get new orders totaling $250 million to $500 million. American participation was prompted both by delays in the procurement of American aircraft for Europe and by a desire to avoid the permanent dependence of European defense forces on supplies from the United States. All planes produced under the program will go to European forces.

The new NATO program will mark the first time complete aircraft have been purchased in Europe under the offshore buying program.

Under the new plan, the U. S. Mutual Security Agency would decide which aircraft to buy, after evaluating characteristics of European planes and considering the interests of the American aircraft industry. American approval of the plan does not include any commitment for deliveries of scarce American tools and materials to foreign aircraft producers.

The biggest problem in the new plan is not the ordering of aircraft but how to speed the day when European factories really start turning out big quantities of modern planes.

Current information does not reveal the full scope and content of the plan. The American people are entitled to more specific information regarding types and models of equipment, protection of patent rights, offshore production facilities, and the problem of spare-parts supply.

Charter of Preparedness

The approval of a $46 billion national-defense expenditure for the fiscal year 1953 should bring to the minds of all students of our preparedness policies a question as to the sufficiency of our plans and progress.

This stupendous sum is second only to the record-breaking authorization of last year when $77 billion was appropriated for the defense services.

The 1953 appropriation is apportioned as follows: to the Army $12,239,500,000, to the Navy $12,842,459,642, and to the Air Force $21,118,361,770.

The President requested $51,319,709,770. There are indications that deficiency appropriations will be required later to meet the requested amount.

The appalling expenditures for national defense in the atomic age reflect the intricacy and high production skills demanded these days. A big and pressing question is: Which will be the greater deterrent to war—the completeness of atomic destruction or the financial cost of modern defense!

The death of James W. Wadsworth, former United States Senator (1915-1927) and Representative (1933-1950), which is recorded elsewhere in this issue, recalls to mind the National Defense Act of 1920. This act was one of Senator Wadsworth's greatest achievements—and he had many to his credit in the field of economic and social progress as well as in the more specialized field of national defense.

It was Senator Wadsworth who, at the insistence of leaders of the Ordnance Association and of the Ordnance Department of the Army, wrote into that act the famous Section 5(a), which became the charter of industrial-mobilization planning throughout the years between the two World Wars.

This philosophy should be re-examined now, for it has been distorted considerably and to our national disadvantage.

Thirty-two years ago, when Senator Wadsworth arose in the United States Senate to urge the adoption of Section 5(a), he pictured in dramatic terms the full significance of placing *directly* upon the then Assistant Secretary of War the responsibility for the industrial-mobilization plans of the Army. He described the effect of that enactment as providing for the Secretary of War, at his right hand, a Chief of Staff for military affairs, and, at his left, a civilian chief of staff for industrial and technical operations.

Under that provision of law, technical and industrial problems were for many years taken directly to the Assistant Secretary without the delays and the misunderstanding inherent in a military organization.

At the same time that the Wadsworth philosophy was developing, another point of view, closely akin to it, was insisted upon by Maj. Gen. James H. Burns (later Assistant Secretary of Defense), at that time an Ordnance officer assigned to the Assistant Secretary of War, which stressed the need for keeping our reserves of armament and our production facilities always equal to military requirements.

Fundamental in the Burns' philosophy was the thought that all of our planning, military and national, must be on the long-term basis and not from year to year.

A timely step, now that we are spending our resources at such gigantic rates, would be to review the Wadsworth-Burns approach in the hope that we might make more certain the advantages for which we strive.

Senator Wadsworth's charter of industrial preparedness will long stand as a monument to his patriotic service. The National Security Act of 1948 was undoubtedly a great step forward. But for the sake of American taxpayers and of the young men who are being called to military service, it would be well if the Wadsworth-Burns philosophy were reëxamined and reapplied. Both have been fundamental in the American Ordnance Association.

Our Army's Current Tasks

Gen. J. Lawton Collins, Army Chief of Staff, recently listed the following as the principal tasks of the Army as required by Joint Chiefs of Staff plans:

1. Provide the Army forces required for the defense of the United States and the Western Hemisphere against attack including:

(a) Antiaircraft defense; (b) Elimination of any enemy foothold that might be established; (c) Control of sabotage or riot actions which are beyond the capability of civil authority; (d) Assistance to civil defense to the extent that such operations are consistent with military requirements and beyond the capabilities of civil authority.

2. Provide the Army forces required for the United States portion of the defense of Western Europe.

3. Provide the Army forces required for the defense of our national interests in the Far East.

4. Provide necessary mobilization potential in men and matériel to support our forces overseas and to be prepared to meet the Army's wartime requirements under JCS plans.

5. Provide Army support for the Navy, Air Force, and Marines.

6. Provide essential training and material aid to our allies.

To meet these responsibilities, the Army submitted a budget for fiscal year 1953 for 20 divisions, 18 regiments and regimental combat teams, 110 antiaircraft battalions, and approximately 150 other combat battalions.

Six divisions are committed to Korea, five are in Europe, and two others are outside continental limits, leaving seven at home.

New Recognition for Marines

A joint House-Senate conference committee approved a compromise bill

enlarging the Marine Corps and making the Commandant a part-time member of the Joint Chiefs of Staff.

> *Under the provisions of the new bill, the U.S.M.C. Commandant would sit with the JCS as a "co-equal" on matters affecting the Marine Corps.*

The legislation avoids language specifically naming the Commandant as a JCS member, but it has the effect of making him a member when Marine Corps matters are being considered. He would have the same voice and the same right of appeal as other members.

The Commandant would indicate to the JCS chairman which matters on the group's agenda "directly concern" the Corps. Unless overruled by the Secretary of Defense, the Commandant would meet with the JCS when such matters came under study. In case of any question as to whether or not the U.S.M.C. is "involved," the decision will rest with the Secretary of Defense.

In the past, the Navy has represented the Marines on the JCS, although the Commandant has been present on occasion to give advice and testimony. The new legislation also provides for "staff representation in appropriate numbers and approximate levels of the JCS supporting organizations."

> *The new law sets the maximum strength of the Corps at 400,000 men, with no minimum total established. However, the law specifies that the Corps shall not have less than three divisions and three air wings. These would not necessarily be maintained at full strength continuously.*

The new legislation marks the first time that the Corps would be organized on a divisional basis. This will insure that the Corps will not be cut down into small units.

Industrial College Courses

The Industrial College of the Armed Forces has scheduled its sixth annual series of Field Economic Mobilization Courses for the 1952-1953 academic year.

These courses will be presented in the following cities:

Houston, Tex.	Sept. 22-Oct. 3
Wichita, Kans.	Sept. 29-Oct. 10
Baton Rouge, La.	Oct. 13-Oct. 24
Erie, Pa.	Oct. 27-Nov. 7
Long Beach, Calif.	Nov. 10-Nov. 21
Seattle, Wash.	Dec. 1-Dec. 12
Akron, Ohio	Jan. 5-Jan. 16
Tulsa, Okla.	Jan. 19-Jan. 30
San Francisco, Calif.	Feb. 9-Feb. 20
Phoenix, Ariz.	Feb. 16-Feb. 27
Miami, Fla.	Mar. 16-Mar. 27
New York, N.Y.	Mar. 23-Apr. 3
Philadelphia, Pa.	April 20-May 1
Salt Lake City, Utah	April 27-May 1
Knoxville, Tenn.	May 25-June 5
Duluth, Minn.	June 1-June 12

The Field Economic Mobilization Course, of two weeks' duration, is a condensed version of the 10-month resident course given at the Industrial College of the Armed Forces in Washington, D. C. It is part of the Department of Defense program for Reserve officers of all the services and for officers of the National Guard.

> *The course presents the problems confronting the country in a mobilization of the national economy for war; outlines the resources and economies of major world powers and areas; and examines methods and procedures for making the best use of resources in support of the armed forces.*

This broad background orientation is valuable to the officers who would be called to command, staff, and planning assignments. The approach is entirely educational as the college is not an advisory, planning, or operating agency.

For attendance at the courses Reserve officers should apply, through military channels, to the respective army, naval district, or air force commanders within whose command the course is being presented. National Guard and Air National Guard officers should communicate with the Chief, National Guard Bureau. Upon selection, officers are ordered to active duty for the period of instruction.

Executives of industry, educators, and prominent citizens are also invited to attend. For civilians the schedule is limited to four hours daily for two 5-day weeks. Civilian participants are selected by civilian committees appointed by leaders in the local community.

Decentralized Procurement

The Air Force announced that the purchasing system of its Air Matériel Command will be decentralized into nine depots next fall.

> *Each procurement district will have primary responsibility for a certain class of items. However each depot commander will have blanket authority to purchase any item up to $10,000, regardless of type or intended use.*

An exception to the decentralization has been made in the case of airframes, engines, propellers, Government-furnished property, items requiring extensive engineering, and initial spares and spare parts.

Wright-Patterson Air Force Base, near Dayton, Ohio, will continue to handle procurement of these items.

The nine depots are located at Maywood, Calif.; Dayton, Ohio; Memphis, Tenn.; Middletown, Pa.; Mobile, Ala.; Rome, N. Y.; Topeka, Kans.; Shelby, Ohio; and Warner Robins, Ga.

Air Force procurement differs from the Army Ordnance system in that it will emphasize product rather than geographical decentralization.

Thus the procurement of all Air Force clothing and personal equipage will be handled at the Wilkins Air Force Specialized Depot, Shelby, Ohio, whereas the Army Ordnance system would utilize all the resources of a district and would let contracts for items produced in the district ranging all the way from artillery shells to photographic supplies.

The decentralization of Army Ordnance procurement was first undertaken in 1918. Eventually fourteen districts were established on a geographical basis. Offices were established in the industrial centers of the various districts which set about to determine what potential war production capacity existed in case a need for it arose.

After twenty years of extensive industrial planning, the Ordnance districts met the supreme test of World War II with great competence.

Preparedness—for the Long Pull

An Editorial

ON the same day the steel strike settlement was announced at the White House in late July the Bureau of Labor Statistics reported that the cost of living had reached a new peak. It was 189.6 per cent of that in the base period of 1935-1939, or almost double.

The end of the 54-day strike will mean full production. Management got something. Labor got something. Everybody is happy except the American taxpayer who will, as usual, foot the bill.

We may expect another climb in the cost of living. When the full impact of the new steel rates is felt, quite a few families, unable to adjust their incomes upward, will be hit hard.

Arms and Solvency

The two essential components of our national-defense program are arms—and solvency. To be strong militarily and weak economically would be just as dangerous as to be strong economically and militarily unprepared.

This is no time to be weak in either important segment of our national life. We must keep our powder dry—and avoid an inflationary disaster. Our goal can only be achieved in terms of a realistic, consistent, unwavering, and unflagging program of national preparedness on all fronts.

In the crisis now confronting us we should attempt to rid ourselves once and for all of our notorious tendency to play by ear, to rely on last-minute improvisations, to solve our national-defense problems by guess, by hunch, by loud propaganda incantations, by crystal balls and tea leaves.

That we are still operating under the old hit-and-hunt system is indicated by recent reports that industrial-mobilization progress is being paralleled by military manpower cutbacks. It is still difficult for us to understand how we can hope to achieve a reasonable degree of security if we have arms without men.

The Defense Production Administration announced that, by the end of June, more than half of the Government-assisted program had been achieved. The agency estimated that $9.5 billion worth of new production and transportation facilities had been completed by June 30th. This amounts to 54 per cent of the dollar value of the bulk of industrial facilities which received large amortization allowances as of March 31st.

Regular Units To Be Cut

At the same time, however, the Army is preparing to reduce all Regular units in this country, with one Airborne exception, to about sixty-four per cent of their war strength. Also predicted is a ten per cent reduction in the personnel strength of our divisions in Germany.

Economy-mindedness in our national-defense program is highly desirable. But even a passion for economy, should it ever occur on the humid banks of the Potomac, should never be permitted to injure and subvert what has already been achieved at such heavy cost to the taxpayer.

Deliveries Total Eight Billion

The sixth quarterly report of the Office of Defense Mobilization, dated July 1st, showed that the total value of deliveries during the previous quarter, in all military procurement and construction programs, was $8 billion. This is more than six times the rate of procurement and construction at the time of the invasion of Korea two years ago.

Almost all the increase during the past quarter came in the "hard-to-get" military items; that is, the newer and more complicated weapons on the military procurement list. On a tally sheet of 120 major items, including those that have presented the greatest design and production difficulties, the value of deliveries rose nearly 50 per cent between February and March.

That was before the ruinous steel strike. Once again we are confronted with the same agonizing problem—progress in one area irreparably harmed by serious failure in another. Thus a laudable achievement in overcoming design and engineering problems on airplanes, tanks, and other major items was followed almost immediately by a shameful 54-day display of the defense strike technique in a major industry.

The fervent exhortation of the Acting Director of Defense Mobilization has an ironical significance at this time: "I want to say with all possible force and earnestness," John R. Steelman declared, "that every one—Government, industry, labor, the public in general—must continue to do his part without letdown in this period of continuing crisis."

National-Preparedness Teamwork

National-preparedness teamwork by all patriotic citizens for the long pull—this has been the goal and objective of the American Ordnance Association since its foundation. One of the basic aims and purposes of the Association, as stated in its by-laws, has always been "to bring to the attention of the people of our country the necessity for scientific and industrial preparedness and through meetings, conferences, and publications to spread a proper understanding of the need for adequate ordnance and related military preparedness."

The United States is well known throughout the world for the gigantic spurt—followed by the colossal letdown. This election year is bound to be a year of intense partisanship. But our main goal, even amid the distractions of a political campaign, must be to go on building a permanent and lasting shield for our peace and security. Unity and perseverance are the price of ultimate victory.

ASSOCIATION AFFAIRS

• **JAMES LAWRENCE WALSH.**—Col. James L. Walsh, U. S. Army, Retired, president of the American Ordnance Association, Washington, D. C., died at Walter Reed Hospital on June 11, 1952.

This announcement was made in the last issue of ORDNANCE but, inasmuch as the presses were stopped for it, there was not time to record details, especially relating to the funeral.

Colonel Walsh was known throughout the United States as a leader of industrial mobilization. In two world wars his services to his country were of outstanding value to the armed forces. He served as a colonel in the United States Army in the First World War.

As president of the American Ordnance Association he led a large part of the scientific and industrial elements of our country in the rapid mobilization for the present armament program.

A native of Boston, Mass., Colonel Walsh was born May 6, 1885, the son of Judge James Lawrence and Rose (Raycroft) Walsh. He was a student at the Massachusetts Institute of Technology and was graduated from the United States Military Academy in the Class of 1909. Commissioned a second lieutenant in the Army in that year, he was promoted through grades and retired with the rank of colonel in 1922. Almost his entire service was in the Ordnance Department of the Army.

As a young officer he was the inventor of the Walsh sliverless smokeless-powder grain, the patent for which he gave to the free use of the United States Government. Later he was assigned to the design of the disappearing carriage for the 16-inch gun, the largest in the world at that time.

After retiring from the service he became connected with the Bankers Trust Company, New York, becoming assistant vice-president in 1926. The following year he was vice-president and director of the McGraw-Hill Publishing Company and later served as vice-president of the National Bank of Detroit.

In 1919 Colonel Walsh took an active part in the formation of the Army Ordnance Association which, following the unification of the services in 1948, became the American Ordnance Association. A charter member of the Association, he served on its Board of Directors since its foundation. He was the founder and first editor of the Association's journal, ARMY ORDNANCE. He was also the founder and first editor of another of the Association's publications, LOGISTICS.

As president of the American Ordnance Association since 1947, Colonel Walsh led the organization in its many technical and scientific activities and merited for it its recognized place as the leading society in the United States devoted to technical and scientific preparedness. The Association now comprises more than 35,000 members, including many of the leaders of science and industry throughout the country.

In the First World War, Colonel Walsh served as assistant to two Chiefs of Ordnance of the Army, first with Maj. Gen. William Crozier and subsequently with Maj. Gen. C. C. Williams. He saw foreign service in Mexico, England, France, Belgium, Italy, and Austria.

During the period between the two World Wars he served as chief of the New York Ordnance District from 1923 to 1932 and subsequently was a member of the district's advisory board.

During the Second World War Colonel Walsh served as a special adviser to Lieut. Gen. Levin H. Campbell, Chief of Ordnance of the Army; also as chairman of the War Production Committee of the American Society of Mechanical Engineers and as vice-chairman of the National Technological Advisory Commission, appointed by the then Secretary of War, Henry L. Stimson, in 1940.

In addition to the Distinguished Service Medal, he also wore the Victory Medal, the Mexican Border Service Medal, Mexican Medal (U. S.), and the Order of Commander Saints Maurice and Lazarus of Italy.

In 1941 he was awarded the Crozier Gold Medal by the Army Ordnance Association for outstanding service to the Nation in the field of industrial-mobilization planning. For many years he was a trustee of the Association of Graduates of the U. S. Military Academy.

Colonel Walsh married Miss Mazie Porcher, June 29, 1918. Until recently the Walshes made their home at Summit, N. J. He is survived by his widow; a brother, Raycroft Walsh, vice-chairman of United Aircraft Corporation, Hartford, Conn.; and a sister, Miss Rosemary Walsh of Washington, D. C.

He was a member of the Metropolitan Club and the Army-Navy Club, Washington, D. C.; and the University Club, New York City.

Funeral services were held at Fort Myer Chapel, Friday afternoon, June 13, 1952. The services were conducted by the Rev. John H. Stanton of Johnstown, Pa.

Burial took place in Arlington National Cemetery with full military honors. The following friends and associates were listed as honorary pallbearers:

Maj. Gen. Julius Ochs Adler, Col. Leo J. Ahern, Lieut. Gen. Henry S. Aurand, Brig. Gen. C. A. Baehr, Hon. Karl R. Bendetsen, Mr. Robert L. Biggers, Col. John D. Billingsley, Adm. W. H. P. Blandy, Brig. Gen. Clifford Bluemel, General of the Army Omar N. Bradley, Lieut. Gen. E. S. Brooks, Col. Thomas F. Brown, Maj. Gen. James H. Burns; Lieut. Gen. Levin H. Campbell, Mr. Donald F. Carpenter, Col. Theodore M. Chase, Maj. Gen. John K. Christmas, Mr. Henry L. Clark, Mr. Leo A. Codd, Col. William W. Coleman, Gen. J. Lawton Collins, Maj. C. Stewart Comeaux, Brig. Gen. Benedict Crowell, Brig. Gen. John

For his service in the First World War Colonel Walsh was awarded the Distinguished Service Medal, with the following citation:

"For exceptionally meritorious and distinguished services in a position of great responsibility, first as chief of the Personnel Division, Office of the Chief of Ordnance, which he organized and administered with conspicuous success during the first nine months of the war, a critical period, during which all Ordnance activities depended upon the successful handling of the personnel problem; and later as personal and executive assistant to the Chief of Ordnance, in which capacity his breadth of vision, tact, sound judgment, and loyalty were invaluable to the Government in the numerous highly confidential matters entrusted to his care. In each of these positions his services to the Government were highly conspicuous and eminent."

Ross Delafield, Gen. Jacob L. Devers, Vice Adm. Donald B. Duncan;

Capt. E. M. Eller, Col. Henry P. Erwin, Mr. Benjamin F. Fairless, Hon. John F. Floberg, Maj. Gen. E. L. Ford, Col. David St. Pierre Gaillard, Lieut. Col. R. F. Garner, Col. C. C. Gee, Col. Herbert A. Gidney, Mr. R. E. Gillmor, Mr. E. R. Godfrey, Mr. Norman K. Haig, Gen. Wade H. Haislip, Rear Adm. B. Hall Hanlon, Maj. Gen. C. T. Harris, Jr., Col. A. W. Herrington, Maj. Gen. Everett S. Hughes, Col. Thruston Hughes;

Mr. C. Jared Ingersoll, Maj. Gen Frederick A. Irving, Col. Ronald D. Johnson, Mr. K. T. Keller, Mr. Harvey C. Knowles, Lieut. Gen. Thomas B. Larkin, Lieut. Gen. John C. H. Lee, Brig. Gen. Burton O. Lewis, Col. Henry N. Marsh, Col. Daniel J. Martin, Maj. Gen. Russell L. Maxwell, Lieut. Gen. A. C. McAuliffe, Brig Gen. T. DeWitt Milling, Adm. Ben Moreell, Col. Frederick A. Mountford, Hon. Thomas E. Murray, Adm. Albert G. Noble, Mr. James Parker Nolan, Maj. Gen. J. G. Ord;

Hon. Frank Pace, Jr., Col. F. H. Payne, Col. John S. Pfeil, Mr. Louis F. Polk, Maj. Gen. A. B. Quinton, Mr. Harry S. Robinson, Rear Adm. Walter G. Schindler, Rear Adm. Malcolm F. Schoeffel, Maj. Gen. Leslie E. Simon, Col. John Slezak, Rear Adm. Lewis L. Strauss, Maj. Gen. Paul H. Streit;

Lieut. Gen. Maxwell D. Taylor, Col. Claude B. Thummel, Mr. J. E. Trainer, Maj. Gen. George L. Van Deusen, Mr. Thomas J. Watson, Gen. Yin Shing Wen, Maj. Gen. C. M. Wesson, Maj. Gen. C. C. Williams, Mr. C. E. Wilson, Hon. Thomas Murray Wilson, and Col. Charles D. Wiman.

For more than forty-three years Colonel Walsh had given voluntarily of his talents and leadership to ordnance preparedness. His genial and generous nature, fortified by great energy and enthusiasm, had endeared him to the Ordnance fraternity throughout the land. The fruits of his efforts are evident on all sides, most of all in the success which has met ordnance endeavor throughout American industry, science, and the armed services.

His patriotic philosophy was expressed in these words: "On land or in the air, on the sea or under the sea, ordnance is the crucial factor in any formula for national security. Ordnance is the crux of survival."

No finer tribute could be paid him and his memory than that we of the Ordnance Association continue with increased devotion his work for the security and peace of our country.

On June 9, 1952, Colonel Walsh was presented the following special testimonial scroll signed by Frank Pace, Jr., Secretary of the Army, and Gen. J. Lawton Collins, Chief of Staff of the Army:

"Evidencing the respect and esteem of your comrades, it is with distinct pleasure that we affix our signature to this testimonial.

"Your active military career was marked by outstanding service with the Ordnance Corps of the Army in the Mexican Punitive Expedition and in the First World War, at home and overseas. Since your retirement in 1922 your interest in the service has continued, and in guiding the activities of the American Ordnance Association, for the creation of which you are largely responsible, you have contributed materially to the efficiency of the Army and the security and peace of our Nation.

"We are grateful for the opportunity to record this expression of our personal regard and to tender our warmest felicitations and heartiest good wishes."

The scroll was presented to Colonel Walsh at Walter Reed Hospital two days before his death. The presentation was made by Lieut. Gen. A. C. McAuliffe, Assistant Chief of Staff, United States Army.

• **THE BOARD OF DIRECTORS** of the Washington Post of the Association met recently at the Carlton Hotel. The discussion centered on the program of the Post for the coming year.

It was recommended and approved that a meeting of the Post be scheduled each month, beginning in September and running through the spring of 1953, to be held on the same day each month. It was decided that Washington meetings would be held at a local hotel and that the Post members be requested to send in their reservation requests, together with checks in payment for luncheon, in advance of each meeting.

Suggestions were made for the first three meetings. It was pointed out that the military services are regularly depending upon the use of complex electronic computers, such as the "Maniac," for the calculation of military requirements for products and materials.

It was also pointed out that certain controversies have arisen regarding the ability of this machine to perform certain functions, and it was believed that Post members would be interested in learning the scope of this computer. It was therefore decided that an attempt be made to obtain an outstanding expert in the field to describe the device at a Post meeting.

It was further recommended that a request be made of the speaker to prepare in advance a nontechnical digest for circulation to Post members prior to the meeting.

The Post president, Col. Ludlow King, appointed Dr. Arthur F. MacConochie to follow up on this subject and to make arrangements for a Post meeting to be held on September 15th or later that month.

It was pointed out that the plant-visitation programs of the past had been well received, and it was recommended that a visit to a naval installation be planned for October. The naval installation in Norfolk, Va., was suggested, and it was believed that at least 200 Post members would be interested in attending.

President King requested T. J. McCloskey of the Bureau of Ordnance to investigate the details of arranging such a trip for some time during the middle of October.

Speakers at Post meetings, in the past, have generally been drawn from the Government, and it was recommended that interesting meetings also could be arranged around an industry speaker, with Government guests in attendance.

President King appointed J. D. Browne to attempt to secure the attendance of an outstanding steel or rubber manufacturing executive to address a Post meeting.

It was recommended that the Post support the Industry Armed Forces Conference during 1953, arrangements for which will be made at a later date.

• **AT PORTLAND.**—At a meeting of the board of directors of the Columbia River Post early in June, the following officers were elected for the coming year:

Byron J. Beattie, president; W. L. McCarter, first vice-president; A. F. McGarr, second vice-president; J. A. Gay, secretary; and G. C. Tupling, treasurer.

Members of the new board of directors are W. A. Gish, Edward Haas, Theodore Emerson, J. L. S. Snead, Ashley Greene, Z. C. Hansen, and H. C. Carter.

The Post is planning a membership drive in the immediate future.

• **AT WASHINGTON.**—The Ordnance Development Division of the National Bureau of Standards has been reorganized into three new divisions, and three new division chiefs have been designated. In addition, an associate director for ordnance development has been appointed.

Wilbur S. Hinman, Jr., former chief of the Ordnance Development Division, was appointed to the newly established position of associate director. Mr. Hinman has achieved outstanding recognition as an authority on the radio proximity fuze and radio meteorography. He will coördinate National Bureau of Standards work in the field of ordnance research and development.

The new chief of Ordnance Develop-

In tribute to the memory of Colonel Walsh, the Executive Committee of the American Ordnance Association has unanimously proposed to the Board of Directors that the office of president of the Association remain vacant during the balance of his term of office; i.e., until December 31, 1952. In the interim, the duties of president will be performed by the senior vice-president, Herbert A. Gidney. The members of the Executive Committee, in addition to Colonel Gidney, are: Harvey C. Knowles, Louis Polk, Robert L. Biggers, C. Jared Ingersoll, and R. E. Gillmor. Ex-officio members of the Committee are: Henry P. Erwin, John Ross Delafield, Leo A. Codd, and Florence G. Ferriter.

ment Program A, Myron G. Domsitz, was formerly chief of the Ordnance Engineering Section. Last year he was appointed assistant division chief and chief of the projectile-fuzing branch of the Ordnance Development Division.

The new chief of Ordnance Development Program B, Jacob Rabinow, was one of the designers of the proximity fuze and guided missiles. At the present time he has more than sixty patents granted and pending.

The new chief of Ordnance Development Program C, Dr. Harold Goldberg, is a graduate of the University of Wisconsin in electrical engineering and physiology. In addition to serving on several research and development working groups, he has been granted ten patents and has some fifty others pending in the electronics field.

• **IN TRIBUTE.**—We cite for special commendation the work of 1st Lieut. Edgar Farr Russell, now a member of the Honorary Reserve who, for a number of years, has been doing very unique work among the Washington, D. C., High School Cadet Corps.

It has been nearly a decade now since Lieutenant Russell started the custom of awarding, with the approval of the Association, an A.O.A. medal for outstanding scholarship in the corps. Last year all nine high schools in Washington received the awards.

The presentations are made at appropriate ceremonies to outstanding cadets who are in charge of ordnance in each regiment. The list of awards from their inception follows:

1st Regiment, Central High—1943-1944, Carl Kramer and Fred Klockenbrink (tie); 1944-1945, Samuel Cummings; 1945-1946, James Warren; 1946-1947, Morton Gammerman; 1947-1948, Matthew Pizzi; 1948-1949, James E. Lacy; and 1949-1950, James T. Segnari.

2nd Regiment, McKinley High—1950-1951, David Schiebel; 1951-1952, David G. Ross.

3rd Regiment, Eastern High—1950-1951, Milton W. Chambers; 1951-1952, Donald S. Ruckman.

4th Regiment, Western High—1947-1948, James Melton; 1948-1949, Everett Schwartzman; 1949-1950, Sherwood Reed; 1950-1951, Henry S. Gering; 1951-1952, Thomas A. Darnall.

5th Regiment, Roosevelt High—1950-1951, Richard H. Billings; 1951-1952, Angus R. Shannon.

6th Regiment, Wilson High—1947-1948, Stuart Krasner; 1948-1949, Arthur Dolliver; 1949-1950, Richard Gillespie; 1950-1951, Richard W. Hansen; 1951-1952, Beaumont Martin.

7th Regiment, Anacostia High—1950-1951, Don W. Pelasara; 1951-1952, James Bailey.

8th Regiment, Coolidge High—1950-1951, Jon Updike; 1951-1952, Walter F. Simon.

9th Regiment, Bell High—1950-1951, Henry A. Linck; 1951-1952, Charles H. Fisher.

10th Regiment, Chamberlain High—1950-1951, Alfred Powery.

Lieutenant Russell, who is assisted in this exemplary work by his son, Lieut. (j.g.) Edgar F. Russell, Jr., has established a record which might well be emulated at other high schools throughout the Nation. The Ordnance Association will be very happy to coöperate.

• **THE PARIS GUN.**—The Association has been fortunate in having been able to secure the remaining volumes of that classic ordnance work, "The Paris Gun," by Col. Henry W. Miller and to be able to offer it to A.O.A. members at a special price.

First published in 1930, "The Paris Gun" tells the amazing story of the German long-range weapon that bombarded Paris from a distance of seventy miles during the First World War.

Thought to be out of print, the book (originally $3.75) is now offered to A.O.A. members at the special price of $2.25 as long as the limited quantity lasts. Orders should be sent to the Ordnance Book Service, 705 Mills Building, Washington 6, D. C.

• **JAMES W. WADSWORTH,** a statesman of highest integrity, a member of the Advisory Board of the American Ordnance Association, and formerly a United States Senator and Representative from New York, died in Washington, D. C., on June 21st.

He shared with only two other men in the history of our country the distinction of having become a member of the House of Representatives after service in the Senate. His latest public service was as Chairman of the National Security Training Commission, set up by Congress to work out details of a universal military training program.

Senator Wadsworth, during his long public career, was known as a deep student of national defense and a warm supporter of our armed forces. He was especially close to the Ordnance fraternity of which he was a distinguished member.

When the National Defense Act of 1920 was placed upon the statute books, he led the forces which coöperated with the Ordnance Department of the Army in having written into that law the section which provided for industrial-mobilization planning. Many of his friends frequently expressed to him the opinion that this alone was one of his major defense contributions.

At the time of his death, the President of the United States issued the following statement:

"Mr. James W. Wadsworth, who died last night, was a man to whom the country is greatly obligated. He was a man of independent thought and action who believed strongly in military preparedness. At a critical time in our national history he moved promptly and effectively to alert his associates in the Congress to the importance of military training in the country's defense.

"Mr. Wadsworth was instrumental in adoption of selective-service legislation in both the First and Second World Wars. At the time of his death he was chairman of the National Security Training Commission. He was a true patriot and an outstanding public servant, not only of his State, but of the whole country. Every American enjoys greater security today because of James W. Wadsworth's long interest in military training and national preparedness."

• **LAMMOT DU PONT,** a life member of the American Ordnance Association and one of the world's leading industrial executives and administrators, died at New London, Conn., July 24, 1952. He was the youngest of the three Du Pont brothers who developed the vast modern chemical and allied institutions which bear their family name.

By coincidence, a volume commemorating the 150 years of the Du Pont company, in the record of which Mr. Lammot du Pont took a leading part, is reviewed in the book section of this issue of ORDNANCE magazine (page 312) by Maj. Gen. C. C. Williams, retired Chief of Ordnance of the United States Army, 1918-1930.

Mr. Du Pont was born near Wilmington, Del., October 12, 1880, and was named for his father, who was the first American to build a dynamite plant.

After graduating from the Massachusetts Institute of Technology in 1901 he began his long service with the Du Pont Company, becoming general superintendent in the black-powder department in 1913.

He was elected a director and member of the executive committee of the company in 1915 and in 1926 became president upon resignation of his brother, Irénée du Pont. Lammot du Pont retired as board chairman in 1948.

A life-long proponent of scientific research, Mr. Du Pont contributed singlehandedly in outstanding measure to the military and industrial strength of the United States.

Of sterling patriotism, Mr. Du Pont's intense loyalty to Army Ordnance was instrumental in having the Du Pont Company continue the development and production of military powder and explosives following the First World War when public funds were not sufficient to continue this important work.

Subsequently his leadership contributed to the great success which met the ordnance production program of the Second World War and the present operations of his company in military and atomic-energy fields, all of which are in addition to what is being done for economic development of America. He was a grand citizen, a great engineer, an outstanding administrator, and an intense patriot.

• **ARNOLD W. LENZ,** general manager of the Pontiac Division of General Motors Corporation and long a member of the American Ordnance Association, died at Lapeer, Mich., on July 13th. A veteran of more than three decades with General Motors Corporation, Mr. Lenz was appointed general manager of the Pontiac Division in December 1950.

Born at Hauingen, Germany, Mr. Lenz came to the United States in 1906 and attended the State Normal School of Fredonia, N. Y. He joined the Buick Motor Company at Flint, Mich., in 1916 as a foundry instructor. Later he became superintendent of the Grey Iron Foundry of Saginaw Products Company, becoming in 1927 foundry manager for the Chevrolet Division of General Motors.

He received an honorary degree of doctor of engineering in 1934 from the University of Aachen, Germany, and in the following year was awarded the American Foundrymen's Association Whiting Gold Medal for major contributions to foundry progress.

He participated in an outstanding way throughout the major ordnance production programs of the Second World War and was directing the operations of the Pontiac Division in its participation in the present rearmament program. His loss will be keenly felt throughout the automotive industry and among the Ordnance fraternity.

ORDNANCE R.O.T.C. MEDALISTS

A silver medal and a year's membership in the Association are presented each year by the A.O.A. for award to the outstanding Ordnance student in each Ordnance R.O.T.C. unit of American colleges. This year awards were made to twenty-five students at the following institutions:

J. A. Berrier

C. W. Reich

J. F. Brownell

F. L. Reid

University of North Carolina.—Jerry Allen Berrier was awarded the Association medal in a special cadet ceremony in Riddiet Stadium. He was the regimental cadet colonel and a distinguished military graduate.

University of Oklahoma.—Charles William Reich of Oklahoma City, Okla., was awarded the A.O.A. medal. He was a distinguished military student, a member of Phi Beta Kappa and Scabbard and Blade, and achieved a straight A average in his course.

Georgia Institute of Technology.—Cadet Lieut. Vasel R. Slover, Jr., of Natchez, Miss., was awarded the A.O.A. medal at the annual Honors Day ceremony, May 16th. A mechanical engineering student, Mr. Slover graduates with high honors upon completion of the 1952 R.O.T.C. camp.

Purdue University.—Cadet Lieut. Col. James W. Mayer of Chicago, Ill., was awarded the Association medal. A distinguished military student, he developed and designed an automatic loader for the 2.36- and 3.5-inch rocket launchers. He has waived all personal patent rights on this device in favor of the Government.

Massachusetts Institute of Technology.—A senior student, James F. Brownell of Chillicothe, Ohio, was chosen to receive the Association medal. He was an outstanding student in mechanical engineering.

Marshall College.—Cadet Maj. Fred L. Reid, who formerly served with the 4th Fighter Group, 336th Squadron, was designated to receive the Association medal. At present a junior, he is majoring in biological science.

Michigan State College.—The Association medal this year went to Cadet Lieut. Col. William L. Webb. He was the Ordnance Battalion commander and a member of Scabbard and Blade, Officers' Club, and Pi Kappa Phi.

Louisiana State University.—A junior Ordnance student, Robert N. Tullis, was awarded the A.O.A. medal. He is an outstanding student in petroleum engineering and was designated a distinguished military student.

Hofstra College.—The A.O.A. medal was awarded to Cadet First Lieut. James J. Slater.

Rutgers University.—Louis V. L. Bowers of Somerville, N. J., a former mem-

V. R. Slover, Jr.

J. W. Mayer

W. L. Webb

R. N. Tullis

J. J. Slater

L. V. L. Bowers

ber of the New Jersey National Guard, was awarded the A.O.A. medal. A distinguished military graduate and cadet major, he was awarded the Rutgers University Sophomore Medal in 1950 for outstanding leadership qualities. He majored in nuclear engineering and was commissioned a second lieutenant in the Ordnance Corps of the Army.

University of Cincinnati.—Eugene F. Beckett was awarded the A.O.A. medal on Honors Day on the university campus. The presentation was made by H. R. LeBlond, president of the Cincinnati Post of the American Ordnance Association. A graduate in civil engineering, Mr. Beckett has accepted an Army commission.

Gonzaga University.—Second Lieut. Raymond J. Enneking of Keuterville, Idaho, this year's winner of the A.O.A. medal, accepted a Reserve commission in the Ordnance Corps on May 30th. He was captain and manager of the rifle team and an officer of the Engineers' Club.

The Military College of South Carolina.—Cadet Walter Lewis Yarborough of Darlington, S. C., has been awarded the A.O.A. medal. An outstanding junior at The Citadel, he has maintained an A average in his academics.

Utah State Agricultural College.—Cadet Grant R. Bagley of Richmond, Utah, was awarded the Association medal during the cadet brigade review, held in conjunction with the annual inspection of the R.O.T.C. unit, on May 8th. He held the rank of cadet lieutenant colonel and was the cadet brigade S-4. He was a member of the Scabbard and Blade Society.

Agricultural and Mechanical College of Texas.—The A.O.A. medal was awarded to Cadet Edward B. Dobbins, Jr., of San Marcos, Tex., at a special military ceremony on May 11th. The presentation was made by Col. Parker S. Day, Fourth Army Ordnance Officer. Cadet Dobbins was an outstanding student and regimental operations officer in the cadet corps.

Cornell University.—The winner of the Association medal was Frederick F. Salditt of Milwaukee, Wis. Mr. Salditt specialized in mechanical engineering, with concentration on the design, production, and maintenance of Diesel engines. He was a member of the varsity rifle team and Scabbard and Blade.

Oklahoma Agricultural and Mechanical College.—Cadet Maj. Paul E. Sterba of Owatonna, Minn., was awarded the Association medal. He was a member of the Petroleum Club and three honor societies. A distinguished military student, he received a bachelor's degree in mechanical engineering.

Colorado Agricultural and Mechanical College.—The Association medal was awarded John S. Moffitt, a junior general science major, an active member of Scabbard and Blade, and a 3-year member of the Poudre Muskets drill team.

University of California.—Cadet Lieut. Col. Joseph N. Shaw was awarded the A.O.A. medal. A distinguished military student, he completed his R.O.T.C. program in June and expects to receive his degree in electrical engineering next year. A wartime Navy veteran, his chief military interest is in the field of electronic fire control.

University of Minnesota.—Award of the A.O.A. medal was made to Robert W. Joseph at a review held on May 29th. The presentation was made by Lieut. Col. A. R. Wood, assistant professor of military science and tactics at the university. First Sergeant Joseph was the most outstanding third-year student of the Ordnance R.O.T.C. unit.

Clemson Agricultural College.—The Association medal was awarded to Paul R. Osborne at the annual school celebration held on May 11th. Mr. Osborne stood first in the senior Ordnance course

E. B. Dobbins, Jr.

F. F. Salditt

and eleventh in the graduating class. A native of Tennessee, he is a veteran of 19½ months' service in the Ordnance Corps. He plans to accept a commission as second lieutenant in the Army.

Virginia Polytechnic Institute.—Cadet Capt. Forrest D. Tigner of Atlanta, Ga., was awarded the A.O.A. medal at a dress parade on May 27th. A distinguished military student, he was also president of Omicron Delta Kappa and associate editor of the *Bugle*. He is also a member of Alpha Pi Mu, Pi Delta Epsilon, Order of the Golden Triangle, and a student member of the Y.M.C.A. advisory board.

Lehigh University.—William H. Walters was awarded the A.O.A. medal for being the outstanding Ordnance R.O.T.C. student at the university for the scholastic year 1951-1952.

Valley Forge Military Academy.—Cadet Steuart J. Bailey of Clarks Summit, Pa., was selected as the 1952 recipient of the Association medal for outstanding work in artillery. Presentation of the award was made by Col. Ward E. Becker, commanding officer, Frankford Arsenal, Philadelphia, Pa., at the colorful regimental review on May 18th.

University of Nebraska.—Cadet First Lieut. Christian S. Yamate of Hawaii, a veteran of three years' service in the Regular Army, was awarded the A.O.A. medal. He is a senior in the R.O.T.C. advanced course and a member of Scabbard and Blade. Although specializing in general agriculture, he plans to enter the Ordnance Corps of the Army after his graduation.

E. F. Beckett

R. J. Enneking

W. L. Yarborough

G. R. Bagley

P. E. Sterba

J. S. Moffitt

First Lieutenant Carl H. Dodd Medal of Honor

"USE MARCHING FIRE—and *follow me!*" Shouting this command, Lieutenant Carl Dodd struck out in advance of his platoon to lead the assault on Hill 256, near Subuk, Korea. During the fierce in-fighting that followed, he constantly inspired his men by his personal disregard of death. Once, alone, he wiped out a machine gun nest; another time, a mortar. After two furious days, Dodd's outnumbered, but spirited, force had won the vital hill.

"You were helping, too," says Lieutenant Dodd. "You and the millions of other citizens who have bought U. S. Defense Bonds. For your Bonds, *which keep America strong*, were behind the productive power that gave us the weapons we used.

"I hope you'll go on buying Bonds—always. Because your Bonds—and our bayonets—make an unbeatable combination for keeping safe the land that we all love!"

★ ★ ★

Now E Bonds earn more! 1) All Series E Bonds bought after May 1, 1952 average 3% interest, compounded semiannually! Interest now starts after 6 months and is higher in the early years. 2) *All maturing E Bonds* automatically go on earning *after maturity*—and at the new higher interest! Today, start investing in better-paying United States Series E Defense Bonds through the Payroll Savings Plan where you work!

Peace is for the strong! For peace and prosperity save with U.S. Defense Bonds!

The U.S. Government does not pay for this advertisement. It is donated by this publication in cooperation with the Advertising Council and the Magazine Publishers of America.

ROLOCK
FABRICATED ALLOYS

AN ASSEMBLY THAT
"Gives a Lift"
TO AN IMPORTANT
HEAT TREATING JOB

Four sets of these Stacking Furnace Baskets were custom-fabricated by Rolock to fit pit-type furnaces built by Hevi Duty Electric Company. Photo at left shows bottom grid, mesh disc, lift straps and fastening keys. Photo at right shows complete assembly ready for furnace.

They are used by a nationally known manufacturer for hardening at 1850° F. Material of basket is type 330 stainless steel. Size, each basket, 28" I.D. x 12¾" high. To facilitate handling in and out of the furnace the baskets are securely fastened together with alloy lift straps and keys. Note fabricated bottom grid and mesh disc. All welding is of the highest quality.

Rolock equipment is engineered to suit the specific job . . . for maximum strength . . . for as high a ratio of load to weight as safety permits . . . for handling convenience . . . and for low hour-cost through extended service life. Our engineering department likes to solve problems. Tell us about yours!

Rolock Booth No. 1810, National Metal Exposition
October 20-24, 1952, Philadelphia, Pa.

Offices in: PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS • PITTSBURGH

ROLOCK INC. • 1356 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

16RL52

NEW DEVELOPMENTS

ROCKET-ARMED FIGHTER

The new Lockheed F-94C "Starfire" all-weather interceptor is now in production for the United States Air Force.

Armed with twenty-four 2.75-inch rockets in the nose, the new 2-place jet incorporates electronic equipment designed to locate an enemy aircraft, track it

Starfire carries 24 rockets in the nose.

down, and automatically fire the battery of rockets when proper range is reached.

Although developed from the earlier F-94A design, the F-94C's new engine, armament system, thin wing, and improved electronics equipment have resulted in virtually a new aircraft.

The plane, built to operate day or night and in all kinds of weather, is powered by the Pratt & Whitney J-48 turbojet engine equipped with afterburner. Top speed is over 600 miles an hour.

INGENIOUS ORDNANCE

A device for teaching soldiers to fire 3.5-inch bazookas and 60-mm. mortars without using live shells—thus saving up to $14 a round—has been developed in Japan by two United States soldiers—Maj. John J. Mackel and Cpl. Carl P. Then. Both are natives of Philadelphia, Pa.

Using a blank caliber .22 cartridge for the propelling charge, the two men devised a method of firing a 6-inch steel dart from the bazooka and mortar. Range of the projectile is 50 to 300 feet for the mortar and 100 to 500 feet for the bazooka.

For the mortar they developed a life-sized replica of the shells with a half-inch hole through the center. The .22 shell is placed in the bottom of the hole and the dart inserted on top of it. When the dummy round is dropped into the mortar, the .22 shell is detonated by a firing pin, and the dart is fired.

The bazooka device works on much the same order. The dummy round, with the steel dart and .22 shell, is loaded from the rear of the weapon as in firing a live round. The .22 cartridge is detonated by a spring-trip firing pin, however, where

Remington Rand Methods News

Mechanize your records handling for cost-cutting plant controls

The same time-and-motion principles apply on your paperwork as on production work. Suppose you pay a posting clerk $2,000 a year. If mechanized methods increase her output by only 30%, you gain a clear $600 per year. Here we illustrate *just a few* of the many Remington Rand machines which can help you cut paperwork costs. Such methods also give you more sensitive and more accurate control of plant operations.

Brings the visible records TO the clerk. *Robot-Kardex* already saves clerical time for many firms on inventory control, production control and other operating records. Along with the many advantages of Kardex *visible-control* methods, it also provides the *plus* of push-button, mechanized delivery of the records to comfortable, desk-level position. Delivers any Kardex slide in four seconds average. See booklet **KD-505.**

Brings the card file right TO the clerk. *Convé-Filer* is the newest and most efficient method of handling a large, active card file for production control, unit inventory, parts lists, personnel and other operating records. Any card tray is brought automatically to reference position by pedal-switch, freeing both hands for work on the files. Available for 5x3, 6x4, 8x5 and tabulating-card sizes. See booklet **LBV-537.**

Brings speed to office photo-copying. *Copyfix* is a brand new *ultra-high-speed* mechanized method for producing exact photographic copies of specifications, correspondence, reports, statistics and other operating records. Copyfix eliminates processing through trays of chemicals, washer and dryer. Negative paper is exposed as usual in Portagraph or other contact printer; then processed with positive paper through the Copyfix machine which handles paper up to 14" wide and any length. The entire procedure, from original copy material to perfect, *ready-to-use* copy print, requires less than a minute. See folder **P-334.**

Brings a punch TO the punched-card file. *Card-o-Matic* is a brand-new, labor-saving approach to punched-card billing, inventory control and sales analysis; also for punched-card preparation of orders, shipping labels, parts lists, payrolls, vouchers, etc. Located at the Convé-Filer (or ordinary tub file), this remote-control sensing unit reproduces all desired information from master punched cards. Variable information is entered directly from its keyboard. New detail cards are completed automatically on the Card-o-Matic Punch. For more information, see folder **TM-822.**

Remington Rand INC.

MANAGEMENT CONTROLS REFERENCE LIBRARY
Room 1347, 315 Fourth Ave., N. Y., 10, N. Y.

Please circle the numbers below for literature desired

LBV-537 **TM-822** **KD-505** **P-334**

Name_____

Firm_____

Address_____

City_____ State_____

FOREMOST FOR FLIGHT
SHAFER
CONCAVEX
Aircraft Bearings
Up in the skyways where the real test of bearing performance is made, the superior quality, design and performance of Shafer Aircraft Control Bearings have earned universal preference.
With Shafer dependability you get assurance of maximum bearing life, low cost maintenance, all-round bearing economy . . . and safety. For Shafer Aircraft Bearings are a development of continuous research-engineering that has paced aviation's stiffest bearing specifications throughout the past third century. Write for descriptive literature covering our complete line of both aircraft and industrial bearings.
Features
SHAFER
SELF-ALIGNING
ROLLER BEARINGS
AIRCRAFT • INDUSTRIAL
SHAFER
BEARING
CORPORATION

New Developments

a real round would be set off by an electrical charge. In both cases the gunner does the firing.

The darts are as accurate as the real weapons, and a trainee goes through the actual motions of firing the rounds. The muzzle velocity of the darts is also in direct proportion to that of the actual shells.

STRONGER MAGNETS

A new magnetic material developed by the Naval Ordnance Laboratory, White Oak, Md., exhibits a coercive force of 3,000 oersteds—greater than any known permanent magnetic material. Composed of bismuth and manganese, the new material has a flux density exceeded only by platinum-cobalt alloy. Magnets can be made by power-metallurgy technique, thus insuring close tolerance of complicated shapes without machining. Production involves heating powdered manganese and bismuth at 700 degrees centigrade and hot-pressing the resulting bismuthide at 300 degrees centigrade in a strong magnetic field.

CHEAPER SNORKEL MASTS

A new design of extensible radio and radar masts for snorkel subs, produced by the Navy Bureau of Ships, will result in savings of over $2,500,000. These masts were originally forged and pierced from solid stainless-steel billets, a process requiring 11,320 tons of steel to produce about 400 masts with a finished weight of 400 tons. By using low-alloy steel tubes covered with a skin of monel cladding, metal requirements are reduced to only 465 tons, of which 50 tons are machined away, compared with 10,920 tons of scrap produced by the original process.

NEW BOMB SHAPE

A new universal bomb shape designed for external use on many modern combat planes will permit flight at fifty miles an hour faster than when the World War II type bomb is used, it was announced recently by the U. S. Navy. The streamlined aërial shape was designed for the Navy's Bureau of Aëronautics by Douglas Aircraft Company under the technical designation, "Aëro X-1A, external store."

Formed to look like a slim cigar or supersonic missile, the shape is carefully contoured for lowest drag possible when installed on transsonic or supersonic aircraft. Speed advancements with this bomb as compared with the old bomb shape equal four years of normal airplane development. Fuel tanks on the Navy's new F3D Skyknight night fighter also are formed to this shape and have been undergoing flight tests.

HIGH-ALTITUDE WEATHER

How hot or cold it is from fifty-five to seventy-five miles above the earth may be

ONLY
LURIA ENGINEERING
offers the
ADVANTAGES *of*

STANDARDIZED BUILDINGS

plus all the

adaptability,
flexibility *and*
durability *of*

CUSTOM-BUILT STRUCTURES

Your expansion program need not be a problem. For **high speed** *and* **low cost** *. . . contact your nearest* **LURIA** *representative.*

To achieve utmost *durability of structure*, the materials and construction of Luria Standardized Buildings meet the *most stringent* building code requirements. And because of their *flexibility* and *adaptability of design*, Luria Standardized Buildings make possible almost any type of structure and almost any type of architectural treatment that best suit *your* particular requirements. *This is accomplished without sacrificing the economies of standardization.*

LURIA ENGINEERING
CORPORATION

500 FIFTH AVENUE • NEW YORK 36, N. Y.

DISTRICT OFFICES:
ATLANTA, GA.
BOSTON, MASS.
CHICAGO, ILL.
PHILADELPHIA, PA.
WASHINGTON, D.C.

the Underwood Sundstrand
***automatic* Printing Calculator!**

Looks like only *one* machine!

But this new Underwood Sundstrand Automatic *Printing* Calculator is *really two different machines in one!*

With many advantages for both large and small businesses.

...It's a *Calculator* that keeps a two-color printed record of every operation ...plus the automatic Credit Balance feature.

...It's a *General*-Purpose...*Multi*-Purpose Adding-Figuring Machine that will come up quickly with all the right answers.

With it, an operator can do one type of job after another—without moving from *one machine* to another.

Jobs...from payrolls to inventories. From computing interest to figuring statistical calculations.

It reduces your investment in equipment...in personnel...in desk space. Saves money, time and effort.

Yet . . . the new Underwood Sundstrand Automatic *Printing* Calculator performs *all* of its various operations with only a *10-key keyboard.*

Only 10 numeral keys...*touch-operated* to speed the work...cut tiresome headswing and attendant errors.

Get full information about this important new feature-packed two-in-one machine.

Fill in the coupon and mail it... *right now.*

Underwood Corporation

Adding Machines . . . Accounting Machines . . .
Typewriters . . . Carbon Paper . . . Ribbons
One Park Avenue, New York 16, N. Y.
Underwood Limited, Toronto 1, Canada
Sales and Service Everywhere

Underwood Sundstrand
The Original Touch Method Keyboard

C-9-52
UNDERWOOD CORPORATION, One Park Avenue, New York 16, N. Y.
Please send me your folder on the new Underwood Sundstrand Automatic Printing Calculator.
Name_____
Company_____
Street_____
City_____ Zone_____ State_____

New Developments

determined by the Army Signal Corps through a new method for gathering facts about the weather employing an inflated sphere released after an 80-mile ride into space in an Aërobee rocket.

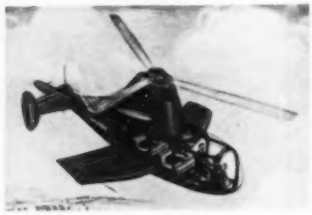
The sphere, which looks like a partially deflated balloon, is carried in a wooden cylinder just behind the nose cone of the rocket. Near the peak of the rocket flight the 4½-foot nylon sphere, especially developed for these tests, is released. Air from a pressurized cylinder finishes blowing up the sphere and gives it shape.

Inclosed in the sphere is an electronic transmitter capable of sending continuous signals to a ground station where the data are recorded. Temperatures in the upper atmosphere can be determined by measuring the rate of fall of the sphere.

HIGH-SPEED HELICOPTER

The Jacobs Aircraft Engine Company, subsidiary of Barium Steel Corporation, has announced plans for the production of a 5-place helicopter of radically new design and performance. Top speeds are estimated at between 185 and 190 miles an hour, with cruising speeds of better than 155 miles an hour.

This new helicopter will be driven by



The Jacobs high-speed helicopter.

an improved standard Jacobs 350-horsepower engine and will attain the high speeds indicated by reason of several innovations. Included in the design is a pusher propeller in the tail, as well as the regular antitorque rotor. The machine will have stub wings with about twenty-six per cent of the normal wing area of a conventional airplane. These wings give lift which helps reduce the vibration of the rotor blade tips enabling the ship to fly at greater speeds than present models.

Many new safety features are incorporated which include placing the gasoline tanks in the wings rather than in the fuselage, a hub of basically new design, a single-piece aluminum rotor blade which prevents fatigue failure at joints, and a fuselage made of tubular steel covered with molded plastic fiberglass having about five times the crash strength of present-day fuselage designs.

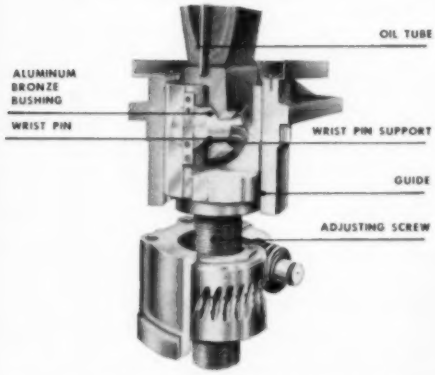
RUBBER LIFEBOAT

The B. F. Goodrich Company, in cooperation with the Navy, has designed a

when you buy presses...

take a close look at

CONSTRUCTION



The Danly slide adjustment mechanism is typical of Danly precision construction. This cutaway view shows how the wrist pin is center supported to eliminate bending and how the entire upper assembly is retained within full length vertical guides, permitting closer, longer wearing machine fits at the wrist pin joint.

DANLY'S extra-rigid precision construction decreases deflection and assures slide alignment and accurate closure. Dies wear longer and can be built to closer tolerances . . . stamped parts stay within tight quality control limits for longer production runs at higher operating speeds . . . quality control is easier and less costly.

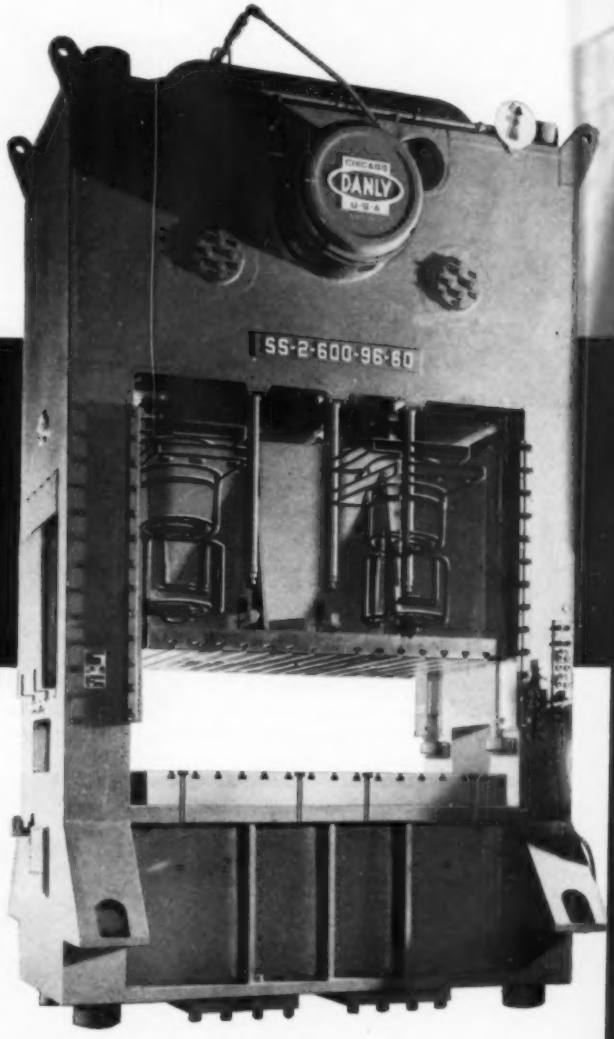
DANLY MACHINE SPECIALTIES, INC.

2100 South Laramie Avenue, Chicago 50, Illinois

DANLY

MECHANICAL PRESSES . . . 50 TO 3000 TONS

HYDRAULIC METALWORKING EQUIPMENT



View of Danly 600 ton Single Action Straight Side Press. Note extra-long oil lubricated gibs.

It costs less to run a DANLY PRESS!

Single Action Straight Side

Autofeed

Underdrive Single, Double, Triple Action

Gap Frame

Double Action Straight Side

Impregnate
PRESSURE CASTINGS
Economically

with the NEW 200 Mogullizer

The remarkable MOGULLIZER offers you a positive, low-cost method of impregnating pressure castings to meet the most rigid specifications. Pressure castings impregnated with this equipment have been successfully subjected to severe tests with hot kerosene, hot oil, hot water and other solutions under pressure, with no evidence of porosity remaining.

Meets All Contract Specifications

If your contract calls for casting impregnation, it will pay you to get the facts today on this MOGULLIZER packaged plant which utilizes both pressure and vacuum stages in its operation. MOGUL Cast Seal B is an approved impregnating solution designed by us for use with the MOGULLIZER. Any impregnating materials can be used satisfactorily in these machines.

Designed for High Production

We manufacture other units to meet the needs of every application. We can also furnish special refrigerated units as well as polymerizing tank for use with the MOGULLIZER. Let us know what your production requirements call for.

Write today . . . for free MOGULLIZER literature and our recommendations for your casting salvage problems.

NOTE: There are job shops in certain areas that can take care of your contract work. A few territories are still open for job shop installation. Write for set-up plan today.

METALLIZING COMPANY OF AMERICA

Dept. OM, 3520 West Carroll Avenue
Chicago 24, Illinois
Telephone: SAcramento 2-3710

MOGUL

New Developments

rubber lifeboat that inflates in half a minute and provides protection for fifteen occupants against subzero temperatures. In recent tests at Floyd Bennett Field the airborne lifeboat was dropped into water from a helicopter, and "survivors" scrambled aboard handily. Within thirty seconds after it touched the surface of the water it ballooned into shape and raised its own protective canopy.

Previous Navy tests showed that the canopy was adequate to protect survivors from blistering tropical heat and was equally sufficient to retain the body heat from fifteen men at a 70-degree temperature in cold weather. The boat has a 3-inch-thick floor liner which can be detached and used as a separate life raft if desirable. This "floor" is inflated with a hand pump and can be removed in hot weather to take advantage of the cooling effect of the water against the bottom of the boat.

NEW METAL DEICER

Revolutionary aircraft deicing equipment developed at Lockheed Aircraft Corporation will make planes fly faster and solve many problems of high-altitude flight. Flight tests on an F-94 are now under way, following trials atop Mt. Washington, N. H., one of the world's coldest spots.

Made of metal, the deicer boosts speed by erasing the drag of present rubber equipment. Improved electrical design makes the new metal boot, for both wings and tail, more effective than any previous type, it is said.

COMMERCIAL VEHICLES

Substitution of commercial for more expensively built tactical vehicles has been adopted by the Army in certain types of units as a general policy in order to save money. At the present the plan is being put into effect in all antiaircraft artillery units stationed in the United States and not scheduled to be sent overseas, as well as in administrative and rear-echelon units overseas and in the continental United States. Commercial vehicles will be substituted gradually as new units are activated and as tactical carriers become worn out. No sudden mass procurement of commercial vehicles is involved at this time.

CAPSULE COCKPIT FOR JETS

The Naval Bureau of Aëronautics recently revealed details of its new "bail-out" cockpit capsule, which provides jet pilots a safe means of emergency escape at supersonic speeds, and announced that the device has passed preliminary tests and is ready for use.

With the new device, when a pilot finds it necessary to bail out of his jet plane in a hurry he touches off a rocket charge

KNOW-HOW IS IMPORTANT!

DEFENSE PRODUCTION!

Greatly Increased Today, and Ready for Far Greater Demands Tomorrow

AIRCRAFT ENGINE PARTS	ROCKETS and OTHER PROJECTILES	WHEELS, BRAKES, HUBS and DRUMS FOR ALL MILITARY VEHICLES	SHELLS and SHELL CASINGS

(Also Electric Brakes, Brake Power Equipment, Power Chambers and Valves for All Military Vehicles)

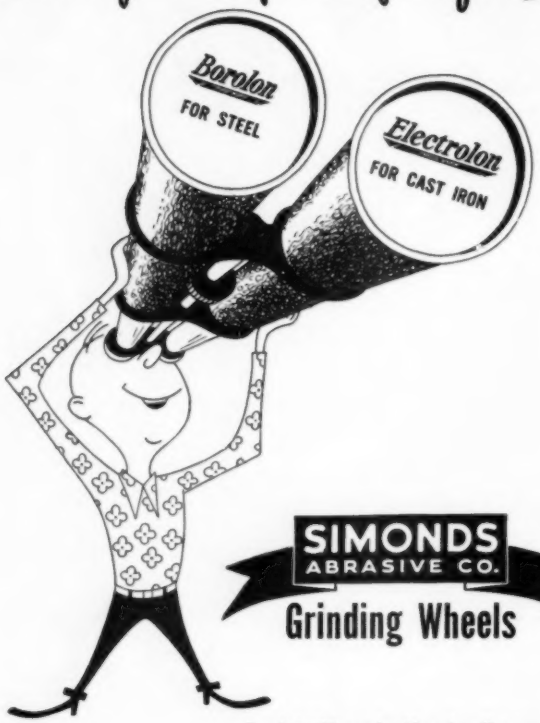
KELSEY-HAYES WHEEL COMPANY

EXECUTIVE OFFICES, MILITARY AVENUE • DETROIT 32, MICHIGAN

Automotive Suppliers of wheels, brakes, hubs and drums for passenger cars, buses, trucks and tractors; also manufacturers of electric brakes, brake power equipment, power chambers and valves for civilian vehicles; Foundry, machining, assembling facilities

7 GREAT PLANTS: Milwaukee, Wis.; 2 Plants in Detroit; Jackson, Mich.; Davenport, Iowa; Los Angeles, Calif.; Windsor, Ont., Canada

Better grinding in sight for YOU!



SIMONDS ABRASIVE CO.
Grinding Wheels

Look to Simonds Abrasive Company grinding wheels for the utmost in grinding efficiency and economy. You'll find the right wheels for *all* your jobs in Simonds complete line . . . Borolon (aluminum oxide abrasive) and Electrolon (silicon carbide abrasive) grinding wheels in vitrified, resinoid, silicate, shellac (elastic) bond processes in all shapes and sizes . . . mounted wheels and points, segments and abrasive grain . . . consistently dependable production tools . . . accurately specified and manufactured under exacting Simonds conditions of quality control.

Send for free data book and name of your distributor.

SIMONDS ABRASIVE CO., PHILADELPHIA 37, PA. BRANCH WAREHOUSES: CHICAGO, DETROIT, BOSTON
DISTRIBUTORS IN PRINCIPAL CITIES

Division of Simonds Saw and Steel Co., Fitchburg, Mass. Other Simonds Companies: Simonds Steel Mills, Lockport, N. Y., Simonds Canada Saw Co., Ltd., Montreal, Que. and Simonds Canada Abrasive Co., Ltd., Arvida, Que.

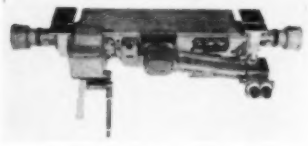
New Developments

which expels the entire cockpit clear of his craft. Three fins unfold at the after end to stabilize the capsule, and a small parachute pops out to slow down its forward speed. When a safe speed is attained a main chute is released, and the capsule is wafted gently to earth.

The entire cockpit is sealed and pressurized to protect its occupant from potentially fatal atmospheric conditions prevailing at altitudes above 50,000 feet. In the event of a water landing the capsule will float, with the storage battery of the mother plane acting as a weighted keel to keep it upright. Wave motion pumps fresh air into the insulated compartment. Included within the cockpit is the usual survival gear similar to that stored on a Navy life raft.

NEW RANGEFINDER

A tank gunner's chances of zeroing in on a target and making his first shot a hit have been greatly increased by a new optical device developed by Army Ordnance for the new medium tanks. The



The new tank gun rangefinder.

device is a complex rangefinder of precision optical, electronic, and mechanical systems. Data on the range and speed of a target as well as the type of ammunition the rangefinder is set for are automatically applied to the big tank gun.

IMPROVED PULSEJET

A pulsejet engine, of the type used in the so-called "flying stovepipe" of World War II but with an operating life of 200 hours instead of 40 minutes, has been developed in the thermodynamics branch of the Naval Research Laboratory. The new engine is expected to find military use primarily in subsonic, expendable applications, such as in guided missiles.

Because the operating life of 200 hours compares favorably with the normal flight time before overhaul of conventional reciprocating aircraft engines, and because the engine is light, simple, and easy to construct, it is expected to advance the application of pulsejet engines to helicopter rotors. Several aircraft companies now are investigating such applications under Government contracts.

NEW FABRICATING UNITS

Packaged steel fabricating units, adaptable for a host of industrial uses, were

RIGHT on the job!

DELCO RADIO

Producing all types of radio equipment is a job for which Delco Radio is well qualified. Delco Radio has the experience—**long** experience in radio designing, testing and production. Delco Radio has the facilities—**vast** production lines, skilled workers, the finest of tools and equipment. And Delco Radio is on the job **now.** A wide variety of advance-type radio equipment is flowing from these same production lines to the aid of America's armed forces. You can count on Delco Radio for quality, quantity and **quick** delivery.

Leader **IN PRODUCTION**

Delco Radio is the world's largest builder of automobile radios—the leader in production and assembly of component parts.

Leader **IN ENGINEERING**

Delco Radio developed many of the most important advances in automotive radio . . . has outstanding experience in this field.

Leader **IN QUALITY**

Each and every step in the manufacturing of Delco Radio products is closely supervised to maintain high, uniform product quality.

Leader **IN MANUFACTURING**

Completely integrated for efficient production from raw material to finished product, Delco Radio meets any customer need.

DELCO RADIO Division of General Motors
Kokomo, Indiana

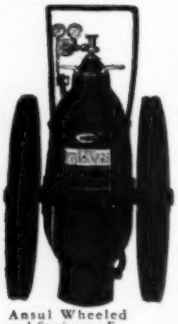
IN THE FRIGID ARCTIC... ...ON THE HOT DESERT SANDS

ANSUL ALL-TEMPERATURE FIRE EXTINGUISHING EQUIPMENT IS YOUR *BEST* PROTECTION

FOR FLAMMABLE LIQUID, GAS AND ELECTRICAL FIRES

Ansul Low Temperature Dry Chemical Fire Extinguishers, Models LT-4-A and LT-20-A, have been tested and approved for operation at 65° F. below zero. These same extinguishers will withstand prolonged exposure to temperatures ranging up to +160° F. They are recommended for use where extreme temperature conditions prevail . . . where other types of fire extinguishers may be inoperative or ineffective.

MODEL LT-4-A ABOVE, CENTER MODEL LT-20-A



Ansul Wheeled and Stationary Extinguishers can be provided with special hose to allow operation at temperatures lower than —40°F.

For flammable liquid fires, Ansul Dry Chemical Fire Extinguishers have the greatest fire-killing ratings ever attained by hand and wheeled portable fire extinguishers . . . Based on tests by nationally recognized approval agencies.

NOTE THESE IMPORTANT ANSUL FEATURES . . .

- Patented nozzle provides most effective stream pattern.
- Easy, on-the-spot recharging. (No tools needed.)
- Low maintenance costs — no annual recharge necessary.
- Water-tight, corrosion-resistant construction.
- Safe to use on electrical fires.
- ANSUL *"PLUS-FIFTY"*® Dry Chemical is non-toxic, non-abrasive, non-corrosive.

Get the facts. See comparative effectiveness ratings for various types of approved fire extinguishers. Write for File No. 694. You will receive complete information and other valuable data.

ANSUL CHEMICAL COMPANY
Fire Extinguisher Division
MARINETTE • WISCONSIN

DISTRIBUTORS IN ALL PRINCIPAL CITIES IN THE U. S. A., CANADA AND OTHER COUNTRIES

New Developments

unveiled recently by the Acme Steel Company of Chicago. This material consists of slotted steel angles, specially designed for all-purpose construction.

With these units, equipment can be built to exact specifications as it is needed, and alterations and additions can be quickly made. When the equipment has served its purpose it can be dismantled and returned to stock or reassembled in another form.

ARMY RIFLES AVAILABLE

Rifles and blank ammunition for funerals and other ceremonies are available to recognized veterans' organizations for the first time since hostilities began in Korea, the Department of the Army announced recently. Limited quantities of rifles can be obtained by those organizations which have not already acquired them. No local organization is permitted more than a total of ten rifles. Requests for rifles should be addressed to the Office, Chief of Ordnance, Department of the Army, Washington 25, D. C.

A charge of one dollar per rifle will be made to cover packing and handling. A certificate "Request for Donation of Ordnance Equipment" must accompany the order. It can be obtained from the national headquarters of the requesting organization. Blank caliber .30 ammunition must be ordered separately from the commanding officer of the nearest Ordnance depot.

IMPROVED CONDENSER

A new main condenser design for surface combat vessels, developed by the Navy Bureau of Ships, increases cruising radius by about 1.5 per cent, occupies only 60 per cent of the cubic volume of older condensers, and results in great savings of critical metal. The new design saves about 7,800 square feet of tube surface for a destroyer. For a condenser serving a 35,000-horsepower turbine, the new design requires 8,900 pounds of copper and 9,000 pounds of nickel less than earlier types.

ONE-PIECE AIRCRAFT WING

Northrop Aircraft, Inc., has recently announced its participation in a research project to produce cast-magnesium aircraft wings. One wing section, sixteen feet long, already has been made out of the light but extremely durable metal. This is believed to be the largest cast aircraft surface ever produced, and it meets the exacting tolerance standards required in military aircraft production.

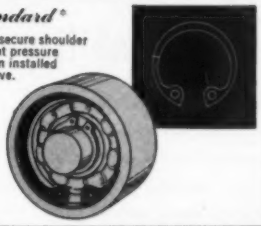
The firm believes that cast wings can be turned out much more rapidly and economically than can conventional aircraft wings, and the use of magnesium in place of aluminum for the castings also bypasses a critical-materials roadblock be-

Speed Production, save material and machining operations with Waldes Truarc Retaining Rings

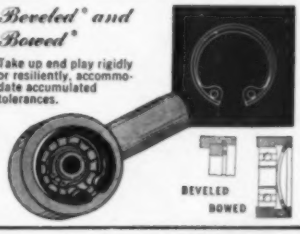
better way to hold parts together

THERE'S A TRUARC RING FOR EVERY PURPOSE

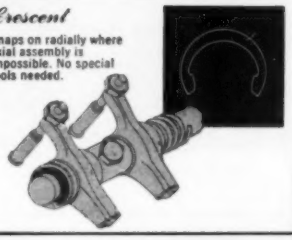
Standard* — Forms secure shoulder for tight pressure fit when installed in groove.



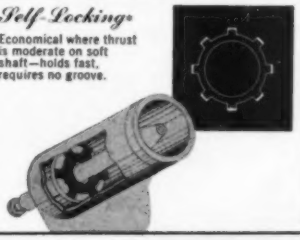
Beveled* and Bowed* — Take up end play rigidly or resiliently, accommodate accumulated tolerances.



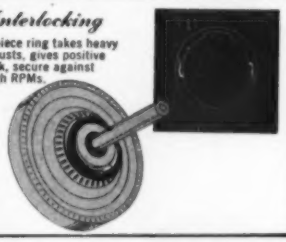
Crescent — Snaps on radially where axial assembly is impossible. No special tools needed.



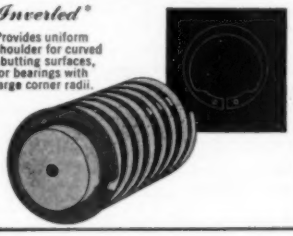
Self-Locking* — Economical where thrust is moderate on soft shaft—holds fast, requires no groove.



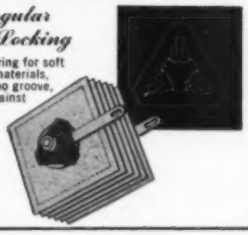
Interlocking — 2-piece ring takes heavy thrusts, gives positive lock, secure against high RPMs.



Inverted* — Provides uniform shoulder for curved abutting surfaces, for bearings with large corner radii.



Triangular Self-Locking — Low cost ring for soft shafting materials, requires no groove, secure against vibration.



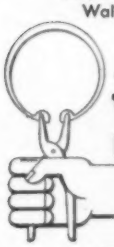
E-Ring — Provides large strong shoulder for small shaft. Applied radially.

*BOTH INTERNAL AND EXTERNAL TYPES AVAILABLE

Thousands of smart manufacturers are *stepping up* production, while actually *cutting* costs—with Waldes Truarc Retaining Rings! Truarc Rings simplify your designs. The ease with which they can be assembled and disassembled makes them superior in many fastening applications where machined shoulders, nuts, bolts, snap rings or cotter pins have been used.

Waldes Truarc Rings eliminate threading, milling and other skilled labor operations... save on material. And there's a Truarc Ring for every purpose... precision-engineered to conform to the highest NAS and SAE standards!

Waldes Truarc Rings are nationally distributed and stocked. Send us your drawings. Waldes Truarc engineers will give your problem individual attention, without obligation.



WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,949; 2,410,052; 2,420,021; 2,420,341; 2,439,705; 2,441,048; 2,455,105; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

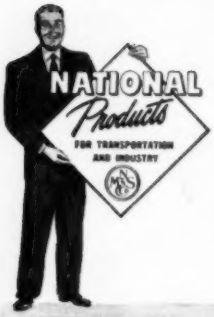
SUB-CONTRACTING FACILITIES AVAILABLE

The same precision production facilities which have turned out millions of Truarc Rings to the most exacting specifications are available to handle sub-contracting of metal stampings. Write directly to Waldes Kohinoor, Inc., 47-16 Austel Pl., Long Island City 1, N.Y.

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y. • MAKERS OF FAMOUS, PRECISION-ENGINEERED WALDES SLIDE FASTENERS AND SNAP FASTENERS

Castings by National

selected for Quality and Dependability



Products bearing these familiar trademarks have all established enviable reputations for quality and dependability.
These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

NORTHWEST
EATON
M W
Kelsey-Hayes
A-C
Budd
CATERPILLAR
American-Standard PRODUCTS
TIMKEN Detroit AXLES
BALDWIN BLH LIMA-HAMILTON

National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants. A-5345

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

SEE "This Moving World"

A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY

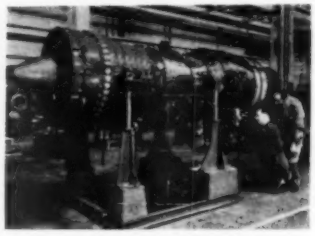
NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO
Est. 1868

New Developments

cause the supply of magnesium—produced from sea water—is inexhaustible.

U.S. BUILDS BRITISH JET

Claimed to be the world's most powerful jet engine, the Bristol Olympus is to be manufactured under license in the United States by the Wright Aëronautical Corporation. Designed by the Bristol Aircraft Company, it is the result of three years' intensive research by Dr. Stanley Hooker, the firm's chief engine designer. In addition to its tremendous power (offi-



The Bristol Olympus turbojet.

cially rated at 9,750 pounds' thrust) the new jet is said to be 15 per cent more efficient than any other engine currently in production.

The secret of this efficiency is found in the engine's high compression, achieved by two sets of axial compressors, one behind the other, each driven by a separate turbine. The first set acts as a supercharger for the second and permits easy starting, rapid acceleration, and low fuel consumption.

NEW COMMUNICATIONS CABLE

A new type of telephone and telegraph cable, developed by the Army Signal Corps and now being used in Korea, will save taxpayers about $18,000,000 in actual production costs during the next twelve months. The savings are based on actual costs of the new cable and estimated cost of the old cable at current prices. The new cable can carry three times as much traffic as the type it replaces.

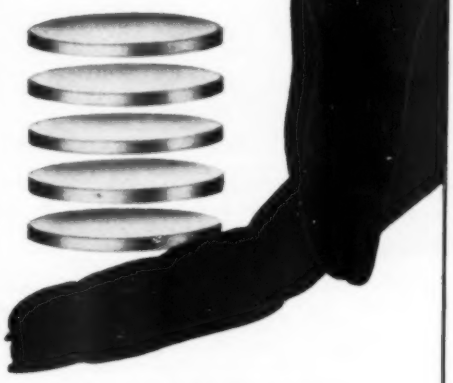
Developed at the Army Signal Corps Engineering Laboratories, Fort Monmouth, N. J., the cable has four separately covered wires which spiral around each other in perfect diamond or square shape. With this system it is now possible to send three telephone and up to six telegraph messages over two pairs of wires at the same time. These messages are sent at different frequencies and separated at the ends of the line.

The new cable is about 15 per cent smaller than the old and a third less in weight—390 pounds per mile as com-

EXPERT FABRICATING TAKES A PRACTICED HAND...

Defense work is work for experts . . . there is no room for mediocrity. For fabricated parts—from brass, steel, or aluminum—enlist the skill and experience of Western Brass Mills. Both of our plants . . . at East Alton, Illinois and New Haven, Connecticut . . . *specialize* in metal fabrication.

The high quality of Western Brass Mills is another example of the superiority America recognizes in all of the many products of Olin Industries.



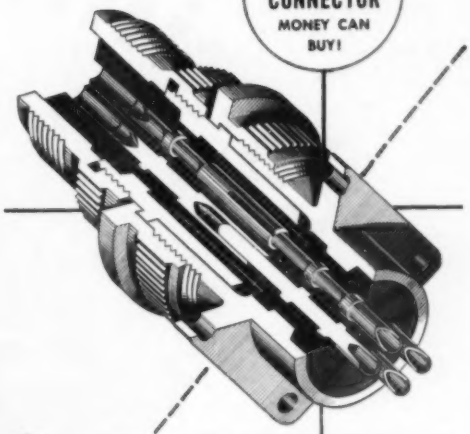
OLIN INDUSTRIES, Inc.

East Alton, Illinois

OLIN *Products of Divisions, Subsidiaries, Affiliates*

BRASS, BRONZE, PHOSPHOR BRONZE, NICKEL SILVER, AND COPPER IN SHEETS, STRIPS, COILS, AND FABRICATED PARTS—FIREARMS, AMMUNITION, TRAPS AND TARGETS, METAL PREPARATIONS, AND ROLLER SKATES—FLASHLIGHTS, AND FLASHLIGHT, RADIO, HEARING AID AND OTHER DRY CELL BATTERIES—BLACK POWDER, DYNAMITE, BLASTING CAPS, BLASTING ACCESSORIES, AND RAILWAY FUSEES AND TORPEDOES—PINE AND HARDWOOD LUMBER—CIGARETTE PAPER AND OTHER FINE PAPERS—CELLOPHANE—POLYETHYLENE PRODUCTS.

The Finest **ELECTRICAL CONNECTOR MONEY CAN BUY!**



SCINFLEX

ASSURES YOU THE LOWEST VOLTAGE DROP IN THE INDUSTRY!

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

BENDIX SCINFLEX ELECTRICAL CONNECTORS

Bendix

SCINTILLA MAGNETO DIVISION of SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California

● TO Cincinnati's Union Terminal come travelers . . visitors . . conventioneers — seeking pleasure, knowledge, products for which Cincinnati is famous: valves, machine tools television sets, soap, A-F Engineered Conveying Systems.

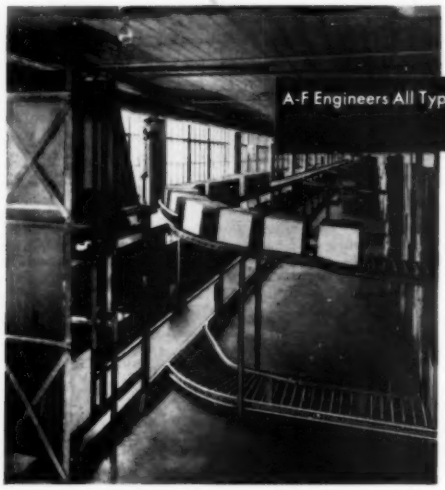
cincinnati

home of

ALVEY-FERGUSON

the original-Since 1901

engineered conveying systems



A-F Engineers All Types of Conveying Systems For All Types of Plants

A-F You can SEE the Superiority of ALVEY-FERGUSON Conveyor Engineering

A-F For a discussion of latest efficient methods of handling products and materials write:

THE ALVEY-FERGUSON COMPANY

532 Disney St. REPRESENTATIVES IN PRINCIPAL CITIES Cincinnati 9, Ohio

pared with 550 pounds for the older lines. New plastics, such as vinyl compounds and polyethylene, replace rubber and rubber substitutes as insulation and jacketing materials, giving better electrical properties with less weight and deterioration. Stainless-steel braiding replaces regular steel, reducing electric losses, improving tensile strength considerably, and enabling the cable to withstand tremendous pulling strain. The advanced design has made it possible to reduce the size of copper strands used to carry the messages, saving about 16,500,000 pounds of copper annually.

HUMAN CENTRIFUGE

The world's largest and most powerful "human centrifuge"—a machine to subject pilots to extreme gravitational conditions encountered in sonic-speed aircraft—was put into operation recently at the Naval Aviation Medical Acceleration Laboratory in Johnsville, Pa.

Built by the McKiernan-Terry Corporation of Harrison, N.J., the centrifuge is capable of accelerating from a dead stop to 173 miles an hour in less than 7 seconds. It will speed up from zero to approximately 90 miles an hour in 1½ seconds.

The giant "whirligig" is capable of exerting a force equal to 40 times the gravitational pull of the earth on a pilot seated in a gondola at the end of a 50-foot rotating arm. It will be used by the Navy to evaluate human tolerance to acceleration and to study the physiological systems which limit the tolerance.

PACKAGING MECHANIZED

A new conveyor system installed at Reo Motors, Inc., has increased by sixteen times the speed of several Ordnance spare-parts packaging operations. Formerly heavy and dirty handwork with a top production of 1,000 pounds of parts an hour, including the degreasing, neutralizing, and application of preservatives, is now completely automatic with a maximum rate of 16,000 pounds an hour. The purpose of these operations on Reo military truck parts is to prepare them to survive ten years of storage and remain in usable condition.

ELECTRONIC RIFLE RANGE

An electronically operated rifle range was tested for the first time recently by the Army at Fort Benning, Ga., and may be the modern replacement for the traditional "men in the butts." The device runs up thirty-six targets which fall electrically when a bullet pierces an electrified screen inside the target.

MOLDING PRESS

A 100-ton precision molding press installed in the plastic branch of the Naval

A BIG PACKAGE FOR LESS THAN A PENNY A DAY!

NEVER before in its thirty-two years of existence has the American Ordnance Association offered its members so much service for such little cost.

• While almost all other costs have continued to rise, the A.O.A. over the years has reduced its membership dues from $5.00 to $4.00 and then to the present rate of three years for $10.00—less than a penny a day!

• For this trifling amount members now receive:

1. ORDNANCE, the bimonthly journal of scientific and industrial preparedness.
2. INDUSTRIAL PREPAREDNESS, a monthly report on the A.O.A.'s Technical Divisions.
3. THE COMMON DEFENSE, the Association's monthly Washington newsletter.
4. An embossed membership card.
5. The privilege of wearing the insignia of the Association—medal, ribbon, or pin.
6. Membership in a local A.O.A. Post with its attendant activities.
7. Many other privileges and services including special reports, plant visits, seminars, national meetings, dinners, and conventions.

• This is indeed a big package for less than a penny a day. Why not tell a friend about the A.O.A. now?

AMERICAN ORDNANCE ASSOCIATION

Dedicated to Industrial Preparedness

LAND • SEA • AIR

705 Mills Building • Washington 6, D.C.

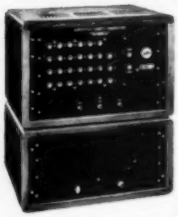
DEPENDABLE
1/8 MICRO-SECOND TIMING

WHEN YOU CAN'T AFFORD TO MISS

IN MEASURING:
- VELOCITY
- ACCELERATION
- DETONATION TIME
- DOPPLER FREQUENCIES
- PULSE CHARACTERISTICS

Potter INSTRUMENT COMPANY, INC.

8 MEGACYCLE COUNTER-CHRONOGRAPH



DIVIDES 1 SECOND INTO 8,000,000 PARTS

GREATER ACCURACY
The use of an 8 megacycle crystal time base provides the highest resolution of time measurement available in direct reading instruments.

COMPLETE DEPENDABILITY
To assure the highest degree of dependability, a straightforward 3-stage binary counter is used at the 8 megacycle frequency, permitting the conservative use of decade counters at the lower frequencies.

DIRECT READING
Digital registration is used to indicate time from 1 microsecond to 1 second by means of 6 Potter decades. Fractional parts of a microsecond are read from a 3-stage binary counter which indicates in steps of ⅛ microsecond.

PROVED PERFORMANCE
Ten years of service in proving grounds and research centers give conclusive evidence that the simplified circuitry inherent in the Potter Counter-Chronographs provides the maximum reliability for critical timing applications.

WIDE APPLICATION
There is a Potter Counter-Chronograph made for your specific application. . . . High-speed digital recorders are available for permanent recording of measurements at rates up to 150 per second.

WRITE FOR INFORMATION AND ENGINEERING DATA

POTTER INSTRUMENT COMPANY
INCORPORATED
108 CUTTER MILL ROAD, GREAT NECK, NEW YORK

MANUFACTURERS OF
PREDETERMINED ELECTRONIC COUNTERS • FREQUENCY TIME COUNTERS
PRESET INTERVAL GENERATORS • HIGH SPEED PRINTING AND
RECORDING, SHIFT REGISTERS, AND DATA HANDLING EQUIPMENT

SEE US AT BOOTH 1101 WEST COAST I. R. E. SHOW

New Developments

Ordnance Laboratory, White Oak, Md., permits molding laminate test panels with precise control of temperature, pressure, and time. Platens are chrome-plated, with parallelism held to 0.006-inch per foot. Pressure up to 347 p.s.i. can be held to an accuracy of 0.2 per cent of the load. Temperatures as high as 500 degrees Fahrenheit can be developed in the platens. Time-pressure history of a molding, or pressure-versus-platen travel may be automatically recorded.

CANNED CLOTHING

They've canned everything else. Now the Air Matériel Command is canning clothing. Test shipments of clothing packed in steel containers have proved them cheaper and better than other types of clothing packages in general use.

The airtight metal containers afford better protection against the natural elements and pilferage, they are fine for storage purposes, and the same cans may be used again and again. Clothing to be canned are the 195 Quartermaster-type items worn by airmen, such as uniforms, underwear, and shoes.

MIGHTY FLATCARS

The first of several hundred huge railway flatcars developed by the Army Transportation Corps are now rolling off production lines and are already being put to use in moving the Army's new tanks and other heavy military equipment. The new 54-foot cars can be loaded with two M47 tanks which heretofore were loaded but one to a car. The tanks weigh 93,000 pounds each, very nearly the capacity of the cars which are rated at 200,000 pounds—approximately double that of the average commercial-type flatcar.

NEW 81-MM. MORTAR

The production model of a new 81-mm. mortar—the M29—was recently checktested by Army Field Forces Board No. 3. This mortar consists of a one-piece smoothbore steel barrel (M29), the exterior of which is helically grooved; a bipod (M23A1) with an overhead, single-type shock absorber; and a circular, 2-piece steel baseplate (M23A1). Primary advantages of the M29 mortar are overall reduction in weight from 136 to 115 pounds; better stability from new baseplate design; greater accuracy with the light, high-explosive, M43A1 shell, especially at longer ranges; and 360-degree traverse without moving the baseplate. The new mortar also permits firing at 4,000 yards with the M43A1 shell. This is possible because of the increase in allowable chamber pressure which permits firing with charges 7 and 8.

60

WIREBOUND BOX PLANTS

are ready to serve you!

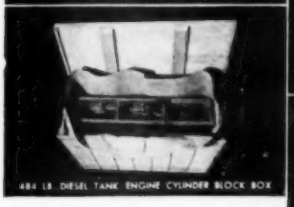
ALL FULLY INFORMED ON SPECIFICATIONS AND REQUIREMENTS OF ALL GOVERNMENT BRANCHES

Strategically located to serve suppliers of all government services, Wirebound Box manufacturers are in excellent position to meet your shipping container needs. Parts boxes, equipment crates, over-packs and food containers are but a few of the multitude of uses for which Wirebound containers are adaptable. Wirebound manufacturers are informed, experienced and technically trained to design, produce and pre-test scientific containers for each use. Make it a point to consult your nearest Wirebound supplier or write for full information.

Wirebound Box Manufacturers Association
Room 1163, 327 South LaSalle Street, Chicago 4, Illinois

CYLINDER BOX

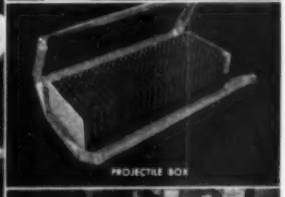
IMMERSION HEATER BOX


484 LB. DIESEL TANK ENGINE CYLINDER BLOCK BOX

FIELD RANGE CRATE

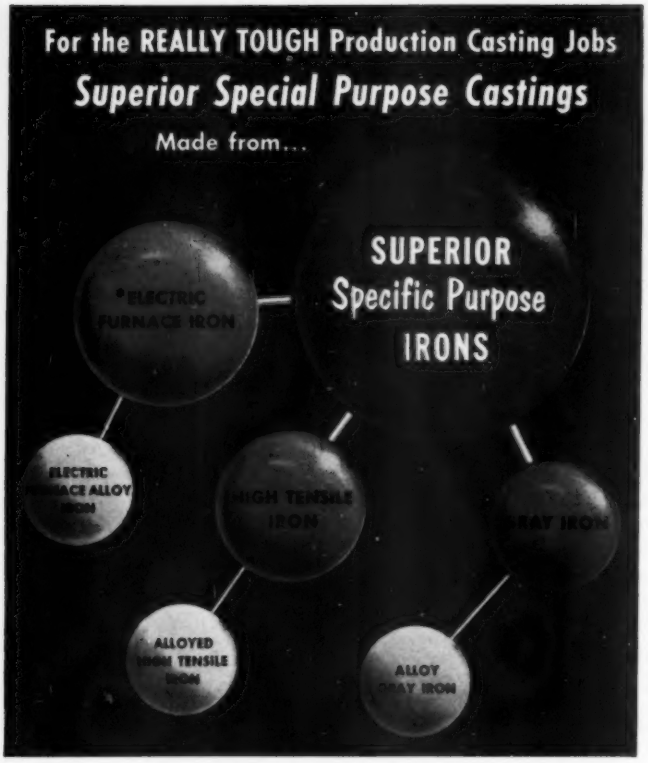
CHEMICAL BOMB BOX

TYPICAL WIREBOUND OVERPACK


PROJECTILE BOX

PRACTICE BOMB CRATE

Wirebound
BOXES & CRATES
Users names on request



Put these outstanding PRODUCTION CASTING FACILITIES to work for You...TODAY!

- Three mechanized continuous mold and sand-handling conveyor systems...
- Quality Controls that extend from sand to shipment—patterns to palletizing...
- Core capacity to serve all molding stations for 250 tons or more of melt daily...
- Tensile strengths up to 60,000 psi in castings weighing 6 to 60 pounds.

BEST EVIDENCE of Superior's completely dependable facilities and services are the prominent manufacturers in many industries whose castings, year after year, are engineered and produced by Superior. It could pay you, too, to consult with Superior...today!

* Write today for interesting booklet describing Superior's unique Electric Furnace facilities.

and here's proof...

TRANSMISSION COVER—smooth appearance, tight fitting, easily machineable. Made of sound, rugged Superior gray iron.

SUPERIOR FOUNDRY, INC. SUPERIOR

3542 EAST 71st STREET • CLEVELAND 5, OHIO

VUlcan 3-8000

Member of American Foundrymen's Society, Gray Iron Research Institute, Gray Iron Founders Society

FROM THE RECORD

THE AIRCRAFT CARRIER

Aircraft carriers form the core of the Navy's offensive power. They were so used with excellent effect in World War II. They are highly mobile landing fields which may move at forty miles an hour to any part of the seventy per cent of the earth's surface that is covered by water.

No international agreements or commitments need precede our use of carriers because they necessarily launch their attack from the international waters of the high seas.

No prearranged base on foreign soil is required as a preface to the use of carriers. Carrier task forces are self-sustaining and replenish themselves at sea. During the Okinawa campaign of World War II, carrier task forces remained continuously at sea off Japan and Okinawa for a period of eighty-seven days and could well have remained longer if the campaign had been extended. . .

A fast carrier task force containing four large carriers can deliver to shore targets in one month the same weight of conventional explosives as the entire German Air Force delivered on English cities in either of the peak months of the blitz.

There is a popular misconception about the carrier that is most erroneous and dangerous. It is frequently said that the aircraft carrier is a "sitting duck"—meaning that it is particularly vulnerable to enemy attack. That is simply not true.

The carrier's mobility and maneuverability make it a poor and unprofitable target for bombing attack, even for attack with the atomic bomb.

Bear in mind that *no man of war of any nation has ever been sunk while under way at sea by high-level bombing.*

In World War II the Navy had a total of 110 carriers, large and small, fast and relatively slow. They spent a combined total of 940 months—over 78 years—in combat areas. They operated by night and by day in all kinds of weather. They were exposed to all manner of attack in restricted European waters as well as in the vast Pacific.

Of our 110 carriers, only 11 were lost, and of the fast carriers of the ESSEX class not one was ever sunk. This is an average loss of one carrier to every eighty-five months of combat operations.

In one period of 13 days off the coast of Japan during World War II, our carriers were attacked by 141 kamikazes, the most deadly of all guided missiles—guided by human brains, eyes, and hands. All of

QUALITY-CONTROLLED STEEL

COLD DRAWN, COLD ROLLED OR CENTERLESS GROUND

Carbon, Alloy, Stainless Steels K-Monel, Bronze or Aluminum

•

Round, Squares, Flats or Special Shape Sections in Wire Sizes in Coils or Cut to Length.

•

Our Complete Chemical and Metallurgical Laboratory Facilities are available.

•

Principal Producers of Ball Bearing and Armor-Piercing Shot Steel.

EATON *Reliance Division*

EATON MANUFACTURING CO.

Office and Plants: MASSILLON, OHIO

Sales Offices: New York • Cleveland • Detroit
Chicago • St. Louis • San Francisco • Montreal

MARKEM®

MM

marks them all

FROM ARTILLERY SHELLS TO MEDICAL AMPULES

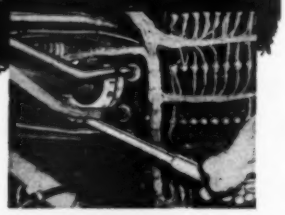
MASTERS OF MARKING — Since 1911

Markem methods, machines, type and inks have been marking the products of industry for forty years. Markem machines can mark up to many thousands of pieces per hour. They make clear, durable imprints on flat, curved or irregular surfaces of paint, paper, wood, glass, metal, leather, plastic, rubber, fabric, composition and pressure sensitive tapes. No special skill is needed for their operation. Legend and color of imprint may be quickly and easily changed.

MAKE YOUR MARK WITH MARKEM

When your products need marking for Identification, Control or Market — ask Markem. Submit your problem, together with a sample of the item to be marked. Markem Machine Company, Keene 9, New Hampshire.

MARKEM
BETTER MARKING SINCE 1911



For generations Tool Engineers have tried to develop a practical Open End Ratchet Wrench. Now *TAC* has done it . . . both as a socket type and as a Crowfoot type.

And what a marvel TAC is! *It ratchets in as little as 7° arc.* It slips over and down on tubing or other standing center assemblies, tightens or backs off nuts or fittings, then slips off again . . . all in a mere fraction of the time otherwise required. Sockets cover the range from ¾" to 4" . . . and adaptors carry the tool's advantages over into Allen head, turnbuckle or screwdriver operations!

Proof of TAC's phenomenal performance throughout all Industry would fill volumes. Our plants are currently producing at capacity for all the Armed Forces and for Defense Industries.

The TAC Open End Ratchet Wrench is fully protected by Patent numbers 2578686 and 2578687, other patents pending. The name TAC is the registered trademark of TUBING APPLIANCE COMPANY.

For information about TAC Wrenches see your Industrial Supply Distributor.

TAC

TUBING APPLIANCE CO.
10321 ANZA AVENUE
Los Angeles, California

© 1952 - TAC

From the Record

the attacking kamikazes were shot down.

In those same 13 days, our carrier aircraft knocked out, on Japanese land bases, over 2,000 enemy aircraft before they could even get into the air.

Carrier task forces are well protected by their umbrellas of fighters carried by the ships themselves. In addition, such task forces are able to put up antiaircraft fire which far surpasses in volume of hot metal any conceivable concentration of artillery fire ashore.

The average fast carrier task group of World War II had a concentration of over 1,600 guns to use in its own defense. When translated into firepower, that means over 6,000 bullets a second or just under 200 tons of steel a minute. . .

It has been publicly stated that the cost of building and outfitting a typical carrier task force is in excess of $3,300,000,000. Those figures are not quite correct. At present prices, a carrier task group consisting of 4 large carriers, 4 heavy cruisers, and 32 destroyers would cost $2,400,000,000 to build and outfit. The annual operating costs for this group would be a little less than $180,000,000.

The figures, however, whether $3.3 billion or $2.4 billion, give a false impression. These estimates presuppose that the cruisers and destroyers are useful only to form a part of a carrier task group. They have numerous other uses and are customarily employed on many other missions. Only one of the functions of cruisers and destroyers is to support carrier operations.

Also, I am certain that if we did not use carriers as we propose to do we would need many more cruisers and destroyers and our fleet costs would mount to a much larger scale than we now anticipate.

After all, the airplane only provides another means of delivering a destructive explosive charge upon the target. Guns do the same thing subject to limitations of range and weight of explosives. If we did not use aircraft for that purpose we would use guns and would require more of them of larger size and consequently more and larger ships upon which to mount the guns.

Just another aspect of this matter of construction costs—we do not expect to build new cruisers in the near future. We already have them. Also we do not expect to build destroyers soon in large numbers. We have them, too. Our proposed destroyer-building program consists of small numbers of modern ships to keep abreast of development in that important type.

So much for carriers in general—their usefulness, their power, their defensibility, their economy. Now to consider why this country needs to build more carriers.

The attack carrier which played such

Flying Tomorrow's Jets

➢ Sperry research engineers are seeking solutions for tomorrow's flight control problems while they develop new ways to better the performance of control equipment currently flying.

➢ This analog computer is duplicating flight conditions of a new high-performance jet bomber being "flown" automatically by the Gyropilot® flight control. Here, for instance, a Sperry engineer checks the performance of the airplane and automatic pilot during the bombing run.

➢ In test after test – in laboratory and its great Flight Research Center, MacArthur Field, Long Island–Sperry flight controls are continuing to prove their capacity to maintain stable all-weather flight in jet, propeller-driven, rotary-wing, lighter-than-air and pilotless aircraft.

➢ For 40 years Sperry has been working continually on flight control problems. With this wealth of experience to build on, tomorrow's problems are being met by today's research and engineering.

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION

GREAT NECK, NEW YORK · CLEVELAND · NEW ORLEANS · BROOKLYN · LOS ANGELES · SAN FRANCISCO · SEATTLE
IN CANADA – SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

AMERICAN CHEMICAL PAINT COMPANY
AMBLER PENNA.

Technical Service Data Sheet
Subject: IMPROVED DRAWING AND COLD FORMING WITH GRANODRAW

INTRODUCTION:

When steel is phosphate coated with "Granodraw" prior to working it, drawing, extrusion, and other cold forming operations are greatly improved. In fact, the protective phosphate coating makes the cold extrusion of steel possible.

Getting cold steel to flow depends on the unique properties of this coating. Its non-metallic phosphate crystals are physically and chemically adapted to acquire a strongly adsorbed lubricant. The combination of adherent phosphate coating and adsorbed lubricating film possesses a low coefficient of friction while maintaining its integrity under extremely high deforming pressures.

The drawing of wire and many other cold forming operations — including the cold extrusion of steel — are greatly facilitated by the application of a "Granodraw" phosphate coating and a suitable lubricant prior to working.

"GRANODRAW" DATA

"Granodraw" zinc phosphate coating chemical is applied to pickled surfaces in an immersion or spray process. When used with a suitable lubricant, the coating reduces friction under conditions of low, medium, or high deforming forces encountered in such typical operations as: cold extrusion of steel; cold shaping; deep drawing (tubs, cartridge cases, shells, etc.); stamping; drawing of wire and tubing; ironing; necking; nosing; and upsetting.

ADVANTAGES OF PHOSPHATE COATING WITH "GRANODRAW" PRIOR TO COLD FORMING STEEL

The following are among the advantages indicated for phosphate coating with "Granodraw" prior to cold forming steel:

Drawing of wire, bars, tubing, etc. — Improved lubrication; improved surface; less scratching; reduced pull; greater percent reduction per pass; reduced die wear; longer die life; lower die maintenance and cost; reduction in corrosion.

Drawing of stampings, shells, shell cases, etc. — Improved lubrication; reduced breakage; reduction in scrap; deeper draws; less scratching; elimination of some annealing; less wear on dies.

Cold Extrusion — Improved lubrication; increased strength of parts; improved surface; reduction in load on press; greater dimensional accuracy; more uniform wall thickness; longer extrusions; elimination of some annealing; less corrosion.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "GRANODRAW" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

From the Record

a large part in the winning of World War II was the ESSEX class. We built twenty-four of these ships, and we still have all of them. Nine are in the active fleet, and fifteen are in moth balls. The design for these ships was completed in 1940. Since that time the design of aircraft has progressed well beyond the capability of the 1940 carrier to handle satisfactorily.

We have modernized the ESSEX class and have greatly increased its effectiveness, but the time has come when we cannot change the 1940 hull to handle the airplanes of 1953 and thereafter.

The MIDWAY class carrier, of which there are three, was completed after World War II but was constructed in accordance with a design completed in 1943.

Dimensions of available aircraft nearly exceed the capabilities of the MIDWAY class. We can do something by way of modernization, but we cannot put the MIDWAY class ships into condition to handle the planes of a few years hence.

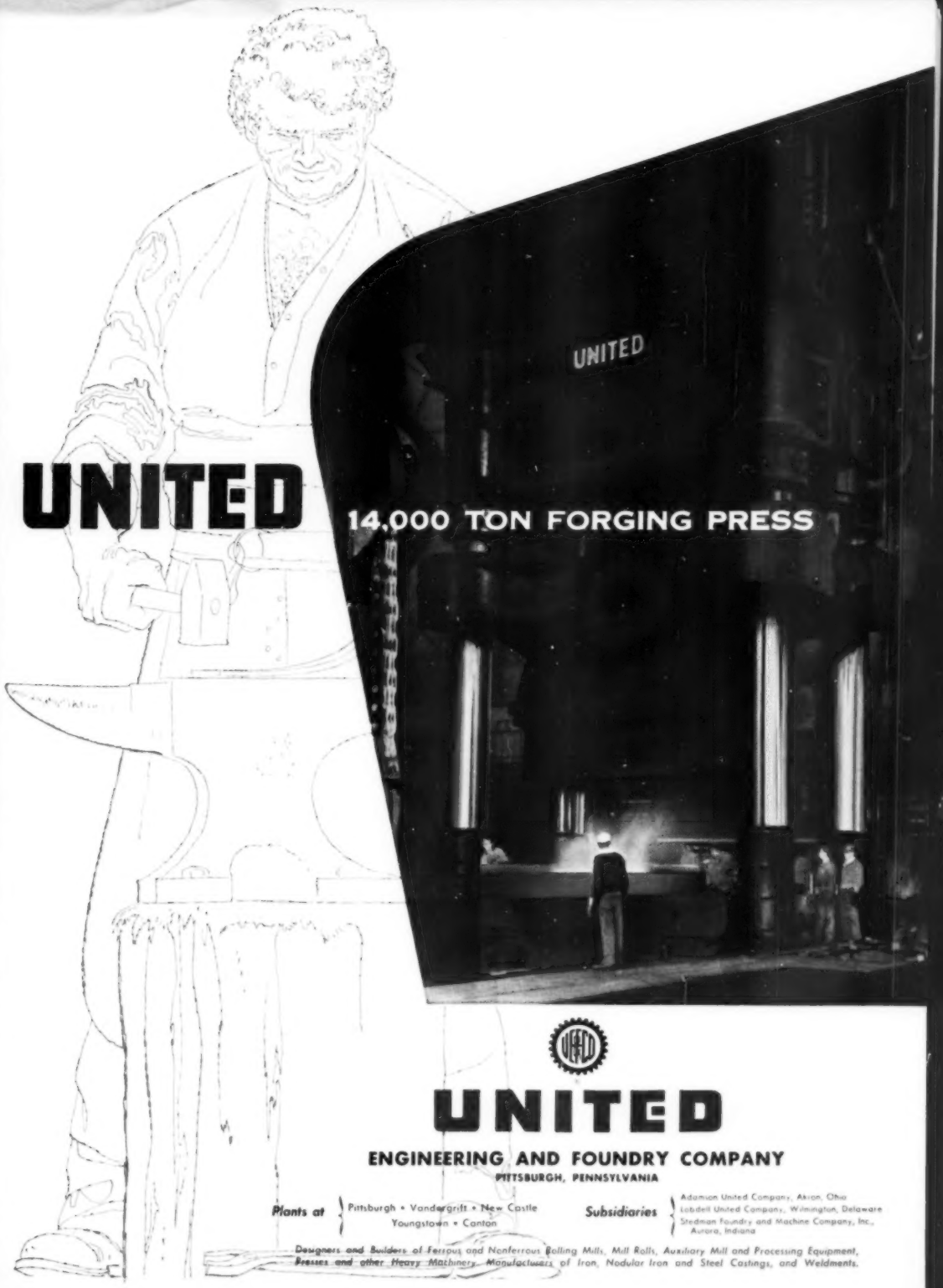
Congress last year appropriated for the first of the modern carriers. It is the ship now in building which will be christened FORRESTAL when it is launched. It will be a flush-deck ship of 60,000 tons' displacement. It can handle the carrier-type planes which will be available before the ship is completed.

Modern carrier aircraft are heavier and larger in size than their predecessors. Being jets they consume more fuel. Their landing speeds are greater. The effectiveness of jet fighters depends upon their being catapulted rather than flown from the flight deck. Their bomb load is greater than that of older planes. They require a bigger ship to service them and to operate them.

There are seven major reasons why we must build these large modern aircraft carriers:

1. The increased weight of aircraft.
2. The need for increased fuel capacity due to jet propulsion.
3. The need for more catapults for launching modern fighters.
4. The need for more aviation-ordnance space.
5. The increased over-all dimensions of modern aircraft.
6. The increase in aircraft landing speeds.
7. The need for better protection against torpedoes, bombs, and other weapons.

This modern carrier is in no sense a "supercarrier." It is merely an orderly step in the natural and progressive development of naval aviation.—REAR ADM. WILLIAM M. FECHTELER, *Chief of Naval Operations, United States Navy, in an address given before the Bond Club of New York.*



UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at { Pittsburgh • Vandergrift • New Castle
Youngstown • Canton

Subsidiaries { Adamson United Company, Akron, Ohio
Lobdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

Our Skills Are At Your Service

The skills accumulated over the years in the development and manufacture of many different types of ordnance components are at your service.

Eastern Tool & Mfg. Co. is now deep-drawing ordnance components to extremely close tolerances thought impossible not long ago.

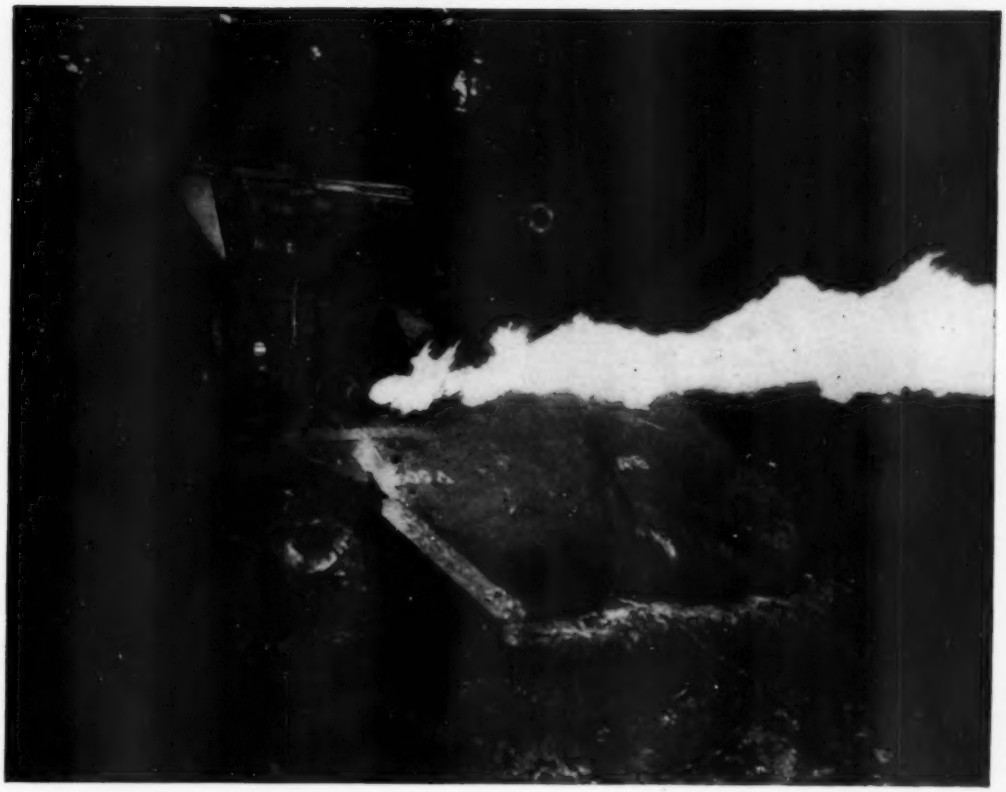
We are equipped and have expanded our deep-drawing operations for ordnance and civilian manufacture or to perform intricate and precise wire and metal stamping and fabricating in our completely equipped plant. In addition, large capacity facilities are offered for assembling, plating, welding and brazing on these components, which can be made from steel, copper, brass or aluminum.

We invite your inquiries.

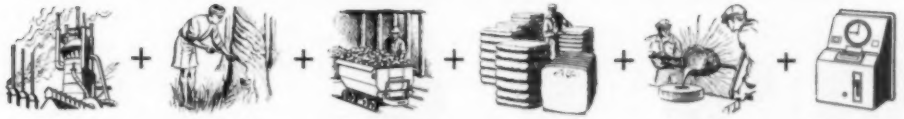
- Deep-Drawing
- Ordnance Engineering and Development
- Wire Forming
- Metal Stamping and Fabricating

Eastern Tool & Mfg. Co.

Belleville 9, New Jersey



What it takes to put a tank into action!



***Your Choice:* 1 Tank or 30 New Cars.** Both require equal amounts of steel, tooling and man hours. But Americans may not have to make a choice... barring an all-out war.

Skill and *Speed* in our mines, our mills, our factories will determine whether or not we can have "guns *and* butter" ... tanks *and* new cars.

If we want both... if we want strength and a richer life in an uncertain world, *skill* and *speed* —individual and collective—must be the daily concern of each and every one of us.

Above figures are given with due regard to security

AMERICAN MACHINE & FOUNDRY COMPANY

Executive Offices, 511 Fifth Avenue, New York 17, N. Y.

AMF does it better—automatically!

CREATORS AND PRODUCERS OF ELECTRONIC AND MECHANICAL EQUIPMENT FOR THE ARMED SERVICES: Radar antennae and drive units • automatic loaders for Army and Navy weapons • elevating and azimuth mechanisms • cooling fans for Army tanks • airplane parts • mobile ovens • electronic training devices • naval ordnance • rolled and welded steel products • shell components • silver-zinc batteries • special military projects.

CANNON PLUGS *to* **ARMY ORDNANCE** *specification*

AO Cannon Type AO Series connectors are manufactured under the latest specification pertaining to electrical systems for military vehicles and associated external electrical equipment. "AO" connectors will mate with standard "AN" fittings. Are ideal for heavy duty industrial use.

This new series is designed to withstand extreme conditions of temperature, moisture, dust, vibration and shock. Shell material is aluminum alloy with natural iridite finish. Insulators are of a special molded resilient material having high dielectric strength, medium oil resistance and will not support combustion. Resilient grommet provides moisture proofing over solder terminals.

For engineering data, request Bulletin AO-1952.

SOCKET INSERT ASSEMBLY TYPE AO-RA00 WITH GROMMET RETAINING NUT

TYPE AO-PA06 WITH GROMMET RETAINING NUT

SOCKET INSERT ASSEMBLY TYPE AO-RB02

PIN INSERT ASSEMBLY TYPE AO-RB02

AO TRAILER RECEPTACLE

DUST CAP

AO SLAVE RECEPTACLE

TYPE AO-22 ANGLE 90° ELBOW

WRITE FOR BULLETIN AO-1952

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. I-133, P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

ORDNANCE IN REVIEW

Since "what is past is prologue" we have thumbed through the musty back files of this magazine to discover what the armament picture was in earlier years and how subsequent developments have changed that picture.—THE EDITORS.

Thirty Years Ago

PROJECTILE DESIGN

To illustrate how unsatisfactory it is to attempt to use actual range firings as a basis for the improvement of projectile design, consider that a projectile has been fired and that its range dispersion has been found to be large. The question arises as to the cause of the dispersion and what must be done to correct it.

Suppose that the powder tests have shown that muzzle velocity is uniform and recovery tests indicate that no fringing and no slipping of the bands has occurred. The dispersion may then be attributed to any one of the following causes:

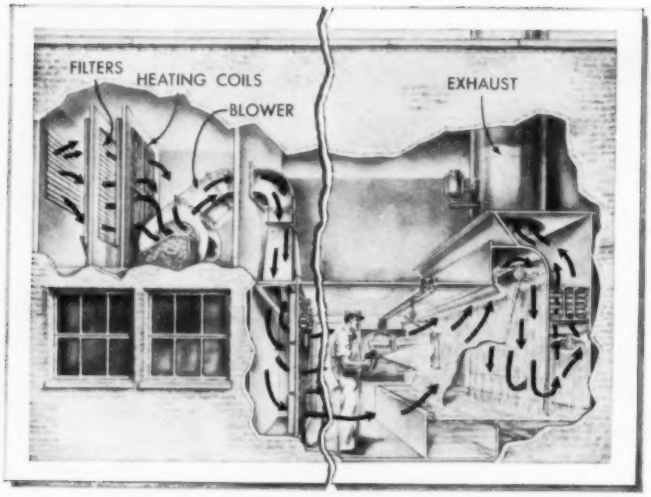
(1) Variation in atmospheric conditions, (2) variations in the shape from round to round, (3) improper action of the projectile in the gun and at the muzzle, (4) improper balance and ratio of moments of inertia, (5) insufficient or too much spin resulting in either great wobbling near the gun or large yaws near the vertex, (6) incorrect shape such that the wobbling near the gun is not quickly damped out.

Any one or any combination of these causes may be responsible for the large dispersion observed. It is obviously impossible to infer from the fall of the shots which of these various causes is preponderant.

It seems evident that in so complicated a question the only hope of reaching a solution of the difficulty, aside from numerous and costly trials of various combinations of different shapes, weights, spins, and balances, is to make a thorough analysis of every factor of the problem.

In fact, to design a projectile without having previously obtained the appropriate aërodynamic data and having calculated the effects of the air forces on the behavior of the projectile is equivalent to designing a gun without any knowledge of the properties of the materials used in its construction and without having made

For over a decade
our entire organization and facilities
have been devoted exclusively to
the design and production of
FLARE AND SIGNAL MUNITIONS
PHOTOFLASH MUNITIONS
DETONATOR AND BURSTER COMPONENTS
FOR AMMUNITION
★ ★ ★
SHELL AND FUZE LOADING
AERIAL PRODUCTS, Inc.
ELKTON, MARYLAND



A spray booth is only 1/2 the picture!

The efficient removal of paint and fume laden air from your spray painting department is of obvious importance. This is the job of Binks Dynaprecipitor Water-Wash Spray Booths. In these miniature Niagaras, overspray pigments and vehicles are washed from the air before it is exhausted outside. You can even collect the overspray pigments for reclamation if you wish to. No other spray booth does such an efficient air cleaning job.

But when air is exhausted from a spray painting department without replacing it, trouble begins. A partial vacuum is created...dust is drawn in...air movements become drafty and irregular...booths don't work correctly...production drops...rejects increase.

That's why Binks offers you, not just a good spray booth and exhaust system, but a balanced air supply system as well...one that brings in from outside the correct volume of fresh air and delivers it to the right area...clean, warm and without drafts and eddies. You get top performance from your booth; adequate air movement to meet all safety and health requirements, but not an excess, which would cause drift and waste of paint.

In short...with a Binks spray booth system you take fresh air from outside, put it to maximum use in your plant and then exhaust it outside again...clean and trouble-free.

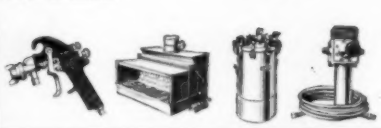
Please let us tell you more

Binks Bulletin 500, showing the operation and advantages of Dynaprecipitor Water-Wash Spray Booths, will be sent free to all requesting it. Or, better still, let a Binks Engineer call at your plant without obligation to discuss this or any other spray painting problem you may have.

Address: Binks Manufacturing Company, 3122-30 Carroll Avenue, Chicago 12, Illinois.

Binks

EVERYTHING FOR SPRAY PAINTING



GUNS • SPRAY BOOTHS • MATERIAL TANKS • EXTRACTORS & ACCESSORIES

REPRESENTATIVES IN PRINCIPAL U. S. & CANADIAN CITIES • SEE YOUR CLASSIFIED DIRECTORY

any calculations as to the ability of the materials to endure the stresses to which they will be subjected.—*From "Projectile Design," by R. H. Kent, published in the January-February 1922 issue of* ARMY ORDNANCE.

The problems of ballistics, like the laws of physics, will always remain with the ordnance engineer, and the solution of these problems will never be easy. See the article, "The Projectile in Flight," by Col. H. U. Wagner on page 339 of this issue and learn how great an effect a small amount of eccentricity in shell wall thickness can have on the accuracy of artillery fire.

Twenty Years Ago

REPORT ON NAVAL ORDNANCE

The Navy Bureau of Ordnance is continuing the development of aircraft machine-gun mounts suitable for the rear cockpit of observation-type airplanes. Aircraft manufacturers have continued in their efforts to help develop this mount in conjunction with Bureau designs and have submitted many new ideas, some of which upon actual service test have demonstrated their practicability.

In continuing the study of bomb-rack design throughout the year, an attempt has been made to inclose more and more of the bomb rack within the fuselage. This results in a decrease in the drag on the aircraft and affords more protection to the bomb rack. Aircraft targets which can be towed at high speeds satisfactorily have been developed and are being issued to the service.

A sufficient number of Mark VI catapults equipped with blast reducers has been provided. All Mark IV-1 turret-type catapults are being equipped with blast reducers as the availability of the various battleships at the navy yards permits.

The work of manufacturing catapult guns, assembling these guns, and testing the assemblies is continuing.—*From "Naval Ordnance during 1931," by Rear Adm. E. B. Larimer, Chief of the Navy Bureau of Ordnance, published in the January-February 1932 issue of* ARMY ORDNANCE.

The airplane catapult, once obsolescent, is again coming to the fore as the best means of launching jet fighters from aircraft carriers. Tests are being made of a new British steam catapult with promising results.

SPECIALIZED

POWER

FOR AMERICA'S ARMED FORCES

IN VOLUME PRODUCTION THE V-32 D-2

Designing, developing and producing powerplants to meet specific requirements of the Armed Forces is a specialty of the Fairchild Engine Division. Designer of the J-44, a unique monocoque turbo-jet, and a major producer of jet engine components, the Fairchild Engine Division now has in quantity production an auxiliary powerplant—the V-32 D-2.

Placed in production on short notice to meet an urgent requirement, the V-32 D-2 auxiliary powerplants coming off the assembly line today are providing electrical power for virtually every large military aircraft. They are another example of how Fairchild's Engine Division produces specialized powerplants to fill our National Defense needs.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Engine Division
FARMINGDALE, N. Y.

•

Aircraft Division
Hagerstown, Md.

Stratos Division
Bay Shore, L. I., N. Y.

Guided Missiles Division,
Wyandanch, L. I., N. Y.

More and more POWER developments for America's Armed Forces

Rockwell Report

by W. F. ROCKWELL, JR.
President
Rockwell Manufacturing Company

BECAUSE we've bought some subsidiaries and divisions and started some others, we are occasionally described as a big company.

Actually, we aren't. We are a number of closely related small businesses, each having the flexibility and independence of a small organization.

We have no ambition for bigness as such. Every affiliated division was acquired or organized with these very specific goals in mind—

To reduce selling costs by marketing a larger number of related products through a single selling force.

To spread the mounting administrative costs of doing business under an enormously complex government.

To secure more modern and efficient production facilities with lower manufacturing costs.

To level sales and employment peaks and valleys.

To lower costs to the customer by bringing manufacturing closer to markets and sources of supply.

Simply building or buying more plants doesn't result in more sales. Our sales growth, we think, is more directly traceable to the basic plan we employ than to the bricks and mortar that house our manufacturing facilities.

* * *

In these days of rising building costs, a surprising number of families are building their own homes. Because our Delta Power Tool Division builds the tools with which so many of these homes have in turn been built, we have put into booklet form the story of one such "home made" house. "Clarence Reithman Had a 'Dream House' and Built it Himself" tells how a young Sidney, Ohio veteran designed and constructed his home for under $7000 complete, and in less than a year. If you'd like a copy, let us know.

* * *

In cities across the country, one of the pressing problems is traffic. City planners say it would even be worse had it not been for the development of the parking meter.

Now, with many cities completely sold on the advantages of metered parking along curbs, the newest trend is toward metered parking lots. A typical example of how this works out is Greensboro, N. C.

By mid-summer, Greensboro will have ten large off-street parking lots in operation. Except for one leased lot, all are city-owned and were paid for with parking meter revenue. The value of the real estate involved was $300,000. Meter charges vary according to the lot's location with respect to the business section.

Like many other progressive towns, Greensboro uses Magee-Hale Park-O-Meters, built by our Tulsa Division and marketed by the Magee-Hale organization of Oklahoma City.

* * *

In our East Chicago, Ind., plant there is a shelf of red-bound books worth hundreds of thousands—perhaps millions—of dollars. They were written in that plant, over a period of 25 years. They are all titled "Laboratory Projects."

In them is recorded the procedure and results of every laboratory investigation that has been carried on there for a quarter of a century. All of these studies have to do with the design or materials of Edward valves, the product built in that plant.

The high value we put on these books is not because of the money that went into these years of experimenting. The value lies in the fact that they answer many of the questions that must be asked when valves are designed for higher pressures, or higher temperatures, or lower temperatures, or any of the extreme conditions that new technologies bring.

These books illustrate the rules we lay down for our research departments: First, today's research should solve tomorrow's operating problems; second, our research must aim directly at constantly improved efficiency of our products.

One of a series of informal reports on the operations and growth of the
ROCKWELL MANUFACTURING COMPANY
PITTSBURGH 8, PA.
for its customers, suppliers, employees, stockholders and other friends

Ordnance in Review

Ten Years Ago

AN INDUSTRIAL RESERVE

I recall the job of cleaning up some defense contracts after the last war and the time and the discussions we had on them. So we recently hit upon a plan and went to Washington with it. Much to our surprise, General Wesson said, "That's just exactly what I wanted."

As an illustration, during the last war [World War I] our Dodge division built a plant and made the recoil mechanism for the 155-mm. cannon. After the war was over, the Army said to Dodge, "We would like you to take the building off our hands."

John Dodge said he did not think so much of the building and did not want it, but they begged him to take it. So he got the building for about thirty cents on the dollar. Then the Army boxed up all the machinery and equipment and sent it out to Rock Island Arsenal for storage. When they were all through, I venture to say that they spent more money boxing up that machinery, shipping it out there, and providing a place to store it than they got for the building in which it had been operating in Detroit.

So we said to General Wesson: "Tanks are a new weapon in the Army. They need a home. Why don't you have a tank arsenal? You're going to need a place, until something new comes along, where you can design, test, and build tanks and where you can keep them in repair.

"Why not put this piece of apparatus in the city of Detroit, alongside a pool of labor such as we have in the Chrysler Corporation—from car unloaders to metallurgists—who fit this kind of job.

"Have that all set up and ready to run about the same as you pipe water into the shower in your bathroom. When you want tanks we move over and make tanks; when you don't want tanks, we move back and, pray God, we make automobiles."

General Wesson said, "That's exactly what we want."—*From "The Detroit Tank Arsenal," by K. T. Keller, president of Chrysler Corporation, in the January-February 1942 issue of* ARMY ORDNANCE.

At the present time the changed nature of the international situation, which portends a long era of threats and rumors of war, indicates the need of going a step farther than having war plants in reserve. To preserve the civilian economy it is now proposed to have plants which are capable, on short notice, of switching from the manufacture of civilian goods to full-scale war production—then back to making consumer goods at war's end.

Nerve center of International Motor Truck Production

New Fort Wayne Engineering Laboratory has the finest engineering and research facilities...

Better trucks for commercial transport, better vehicles for Armed Forces assignment—these will be direct and certain results coming from International Harvester's brand new Engineering Laboratory building at Fort Wayne, Indiana. Here, spreading over 302,749 square feet of floor space, is the most modernly equipped and designed research unit in the motor truck industry, staffed with hundreds of skilled engineering and technical people.

This new motor truck research unit is another progressive step in International Harvester's pace-setting engineering, enabling us to better gear our production to requirements of the Armed Forces.

The competence of International Harvester motor truck engineering is one of the big reasons why International Harvester was chosen as the leading producer of 5-ton, 6x6 military tactical trucks for the Armed Forces, and why its other models are being used for a wide variety of military purposes.

Engineers at work in the Stress Lab testing connecting rods.

A Cathode-Ray Oscillograph — one of many up-to-the-minute laboratory devices.

Connecting rod bores going through a routine check.

INTERNATIONAL HARVESTER Chicago 1, Illinois

Builders of products that pay for themselves in use . . .
International Trucks • McCormick Farm Equipment and Farmall Tractors
Crawler Tractors and Power Units • Refrigerators and Freezers

Book REVIEWS

Review Staff

BRIG. GEN. DONALD ARMSTRONG, *military historian, lecturer, author, manufacturer, Paris, France.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

COMDR. CLARENCE CISIN, *author, editor, Office of the Secretary of Defense, Washington, D. C.*

COL. JOHN J. DRISCOLL, *author, air armament engineer, air combat officer, United States Air Force, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

COL. CALVIN GODDARD, *small-arms authority, Washington, D. C.*

LIEUT. COL. MELVIN M. JOHNSON, JR., *automatic arms expert, inventor, author, New Haven, Conn.*

DR. JOHN J. O'CONNOR, *educator, author, editor, Washington, D. C.*

COL. PHILIP SCHWARTZ, *author, air ordnance expert, European Command, Germany.*

BRIG. GEN. THOMAS K. VINCENT, *artillerist, engineer, author, Redstone Arsenal, Huntsville, Ala.*

The Atom Spies. By Oliver Pilat. New York: G. P. Putnam's Sons. 312 pp. $3.50.

THE author is a professional newspaperman who has studied the activities of the Communists in the United States and abroad over a period of years.

"I wrote this book," he says, "because it seemed to me that the various cases of atomic espionage all gave evidence of the weakness of the United States in the face of ideological conspiracy. One way to meet this threat is to understand what made these people become spies. Obviously none of them—Fuchs, Gold, the Rosenbergs, and the rest—started out to steal the atom bomb. I'm interested in what led them into espionage, and then in tracing their progress from stage to stage until the final crucial moment when they are committed to betraying their country."

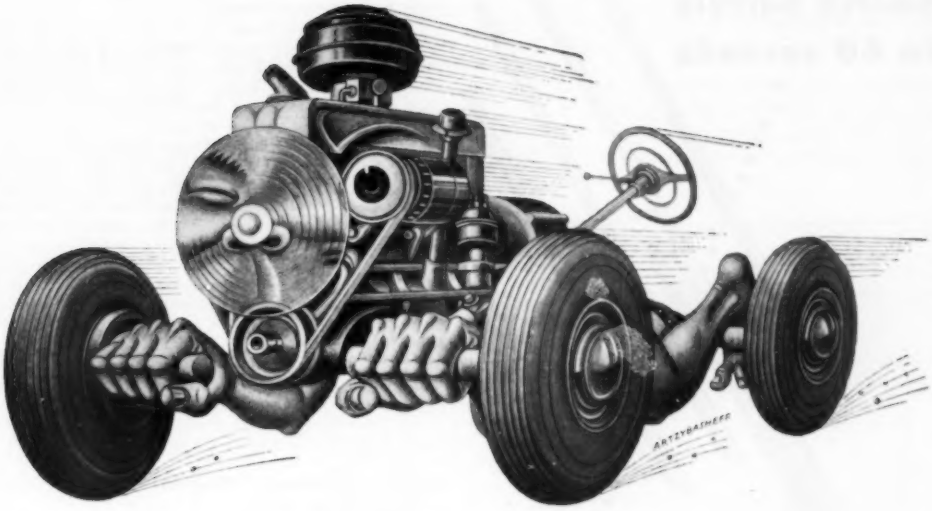
Frankly this is a new approach to the problem of "what makes them tick." Collecting all the bits of data and fitting them together, adding possible and plausible conversation at times, supplying the mental reasoning as well as the arguments, has resulted in a factual narrative that has all of the conviction of history with the fascination of fiction.

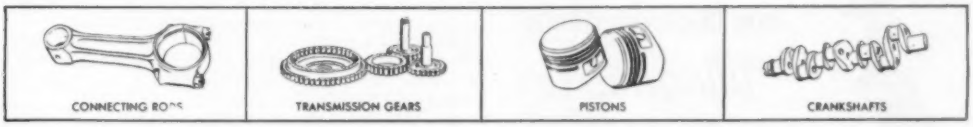
The reader will question the authenticity of some of the conversations but never will he doubt that they occurred. The facts are there and are correct, and his build-up of the story is smooth and plausible in its entirety, for all the garnishment.

The story is in a class with A. Conan Doyle at his best, except for the real characters, true incident, and reasonable deductions.—THOMAS K. VINCENT.

Du Pont—The Autobiography of an American Enterprise. New York: Charles Scribner's Sons. 138 pp. $5.

THIS book covers a period of 150 years—1802-1952—and makes clear the continuous growth of the Du Pont Company. It is worth while to note that the founder of the Du Pont Company, Eleuthere du Pont, was a long-time friend and associate of the great French chemist, Lavoisier. Also, it should be noted that Mr. Du Pont himself was a notable chemist and that from





"Sinews" to give cars "go"

For any or *all*
engine parts—
parts that can "take it,"
leading auto manufacturers
have long depended
on Lycoming
precision production.

To meet today's driving demands—stop-and-go traffic, long "wearing" runs, sudden surges of power—automobile engines require *precision-machined parts* for dependable, efficient operation through the years. That's why the automotive industry has long relied on the skill and resourcefulness of Lycoming for everything from a single part to a complete engine.

Whether you require auto parts or other precision machining, high-volume production, product development—or versatile air-cooled power—Lycoming's extensive research facilities and well-rounded experience stand ready to serve you. *Whatever* your problem—look to Lycoming!

For a more complete story on Lycoming's varied abilities and facilities, write—on your company letterhead—for the interesting, illustrated booklet "Let's Look at Lycoming."

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME-MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

LOOK TO **LYCOMING** FOR RESEARCH
FOR PRECISION PRODUCTION

LYCOMING-SPENCER DIVISION, WILLIAMSPORT, PA.
BRIDGEPORT-LYCOMING DIVISION, STRATFORD, CONN.

AVCO MANUFACTURING CORPORATION

If you're satisfied with nothing less than *the right barrel length and boring* for each kind of shooting, Remington "Wingmaster" is the gun for you.

You can change from long to short barrel...from improved cylinder to full choke or any other in *seconds*. Reason: the barrel can be removed quickly and easily without disturbing either fore-end or magazine tube.

Completely interchangeable "Wingmaster" plain barrels come in a wide choice of lengths and borings...making it possible for you to use one gun for all types of shotgun shooting without the trouble and expense of special fitting.

You'll be delighted with the *many* ways this gun meets your individual preferences. Exclusive Vari-Weight plug in the 12 gauge even lets you adjust the weight. Try it yourself and see why the new Remington "Wingmaster" is America's most versatile shotgun.

"Wingmaster" is Reg. U.S. Pat. Off. by Remington Arms Company, Inc., Bridgeport, 2, Conn.

Serving American Sportsmen since 1816

Remington DU PONT

Book Reviews

its beginning the Du Pont Company has based many of its activities on the science of chemistry.

When Mr. Du Pont brought his family to the United States there was a demand in all parts of the country for a good dependable black powder for all sorts of firearms. Encouraged by Thomas Jefferson, the Du Pont family built a powder plant along the Brandywine River near Wilmington, Del. From the beginning the armed services of the U. S. Government were important customers of the Du Pont Company and still are.

There have been great changes in the powders and explosives used by the armed services, especially during the last fifty or sixty years—and the Du Pont Company has been a most important factor in their development. The making of smokeless powder and high explosives is largely a chemical process, and the Du Pont Company is one of the largest and most important units of the chemical industry in the United States. Its importance to our essential war production has been very great.

"Lest we forget," since 1776 we have fought the following wars: Revolutionary War, War of 1812, Mexican War, Civil War, Spanish War, World War I, and World War II.

The elapsed time from 1776 to 1952 is 176 years—an average of one war for each 25 years or one war for each generation!—C. C. WILLIAMS, *Maj. Gen., U. S. Army, Ret.; Chief of Ordnance, U. S. Army, 1918-1930.*

Witness. By Whittaker Chambers. New York: Random House, Inc. 808 pp. $5.

SOMETIMES I wonder whether any one else in the entire country has shared my experience in the following regard:

Since 1935, when the first printed hearings were published, I have had on my library shelves at home the thirty-odd volumes of testimony before the Nye Munitions Investigating Committee of the United States Senate, 1935-1936.

The availability of the record of those nefarious proceedings during the past sixteen momentous years has been a valued convenience for frequent consultation as to people and policies in the public eye since then. The record is still quite revealing.

It was under the Committee's auspices, led by Senators Nye and Vandenberg, that one Alger Hiss first showed his colors on the national scene. It was then that the Hiss contact with Whittaker Chambers began. Indeed, a great deal of the filthy story of Communist intrigue and of incalculable damage to the national defense of our country got under way there in the Munitions Committee's shadow.

The record of these hearings should be consulted from time to time, for during that period of tragedy for the United States many alleged statesmen and patriots who made their reputations by attacking our "munitions makers" appeared in their true light.

I remember distinctly that, with Alger Hiss as counsel for the Committee, some of us raised our voices on the public platform that there were Communist influences behind the Committee's work. How the press of the country—and notably the religious press—cried us down!

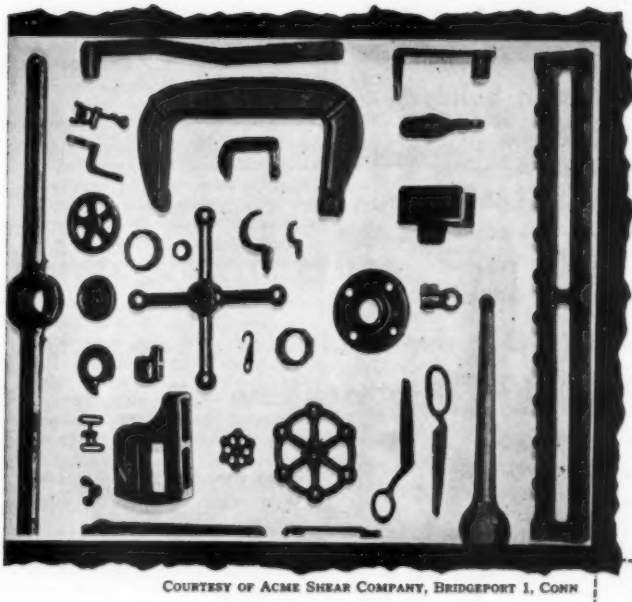
But Whittaker Chambers has clarified all that. For me his amazing story as recorded in "Witness" is the concluding and climactic volume of the Nye-Vandenberg Munitions Committee hearings.

Mr. Chambers is a masterful writer. So also is he a philosopher of depth and penetration, the tragedy of whose life as a Communist is in sharp contrast with the heroism of the life of reform he chose to follow later. I was present the day he publicly confronted Alger Hiss in 1946 in Washington, and from that moment to this I have had no doubt as to his sincerity nor the truth of his story.

For those of us who know the importance of a strong industrial backing for our national defense in peace and in war,

PRODUCT AND PROCESS ADVANTAGES

increase demands for Ductile Iron



COURTESY OF ACME SHEAR COMPANY, BRIDGEPORT 1, CONN

Ductile Iron offers excellent castability, high mechanical properties and good machinability. Castings show superior pressure tightness, good elastic modulus and resistance to shock. They range from those weighing a few ounces . . . with sections as thin as one-tenth of an inch . . . to 50-ton anvil blocks with sections 4' thick.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, NEW YORK

DUCTILE IRON PROVIDES mechanical properties which approach those of cast steel. In addition, it combines the *machinability and wear-resistance* as well as the *fluidity and castability* of cast iron.

Presence of spheroidal rather than flake graphite not only gives this new material ductility that is unique among cast irons, but contributes much to its other exceptional properties.

REMARKABLE CHARACTERISTICS OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness.

2. It can provide a chilled, carbidic, abrasion-resistant surface supported by a tough ductile core.

3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.

4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.

5. It can be satisfactorily welded.

6. It resists oxidation and growth to an extent never before available in gray iron castings.

7. It can be cast in intricate shapes not normally feasible for cast steel.

AVAILABILITY

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron . . . mail the coupon now.

INCO SERVICE

The International Nickel Company, Inc.
Dept. 20, 67 Wall Street
New York 5, N. Y.

Please send me a list of publications on:
DUCTILE IRON

Name_____ Title_____

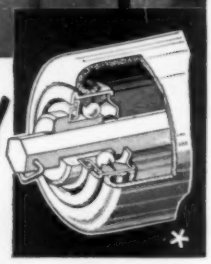
Company_____

Address_____

City_____ State_____

Buschman CONVEYORS

CUT ASSEMBLY COSTS 50%



for automotive transmission builder

More than a year's use shows that a Buschman Roller Conveyor has cut approximately 50% in assembly costs for a noted transmission manufacturer. "Highly satisfied with the installation," the user reports that the conveyor is particularly flexible, permiting time-saving straight line assembly never possible before in this operation.

There's a Buschman Conveyor to move practically any part or product faster, easier and at lower cost. Find out why users in every industry say Buschman Conveyors are "Better Built . . . A Better Buy." Write for literature: Catalog 60—Roller Conveyors or Catalog 400—Complete Conveyor Line.

*Dustproof labyrinth-sealed bearing, the heart of the roller, grease-packed for life. Ideal for heavy duty operation. Free running dustproof labyrinth-sealed bearings of similar design recommended for gravity roller conveyors. There is a type to suit every requirement.

Representatives in Principal Cities
Canadian Licensee: James A. McKehnie, Ltd, Toronto 12, Canada

PRODUCE MORE . . . FOR LESS on Buschman Conveyors

THE
E. W. BUSCHMAN COMPANY
4478 Clifton Avenue
Cincinnati 32, Ohio

Book Reviews

"Witness" is an essential part of the record. It is wonderfully written, although the sad story it tells will bring a blush of shame to all good citizens to think that so many of our fellow Americans were so gullible while traitors were tearing down methodically and perseveringly the last vestige of our national strength.

Not only do I urge you to read "Witness"; with equal appeal I suggest that you look into the Senate Munitions Committee hearings of sixteen years ago and see what some public servants and their Hisses were up to in those days. There the dirty work described by Whittaker Chambers got under way at the doorstep of the United States Senate.—Leo A. Codd.

The Sea Around Us. By Rachel Carson. New York: Oxford University Press. 230 pp. $3.50.

IF all writers of science and other textbooks had the literary skill and ability of Miss Carson, the securing of an education would come under the heading of pleasurable entertainment, and humanity throughout the world undoubtedly would be better informed.

"The Sea Around Us" is written with consummate skill and enduring charm. It is as absorbingly interesting as any work of fiction despite the fact that it deals authoritatively with the results of painstakingly careful scientific research.

Miss Carson's engrossing book covers such topics as the beginning of life in the primeval sea, currents and tides, mineral resources, life recently discovered in the lowest depths of the sea, and a fund of other factual information, some of it never before published in book form.

To those who love the sea, "The Sea Around Us" opens wide many hitherto unexplored and delightful areas. To those whose knowledge of the sea is meager, the book is a passport entitling the reader to first-class passage on a fascinating journey of discovery.—Clarence Cisin.

Winston Churchill. By Robert Lewis Taylor. New York: Doubleday & Company. 433 pp. $4.50.

THIS latest biography of Mr. Churchill is frankly uproarious. It does not take Britain's current Prime Minister seriously at all. Churchill the wit is allowed to dominate Churchill the statesman in what the author properly calls "an informal study of greatness."

It is very informal indeed. Far more attention is paid to the great man's phenomenal consumption of liquor (hard) than to his diplomatic conduct at Teheran and similar weighty conferences. What the study lacks in completeness, it makes up in humor (straight). *(Contd. p. 318)*

81 mm TRENCH MORTAR

Prime Contractor: THE OLIVER CORPORATION

Just one example of what OLIVER is doing...
evidence of the facilities at your command

OLIVER

THE **OLIVER** CORPORATION 400 W. Madison St., Chicago

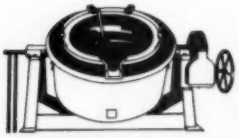
PATENTED KNAPP-LEE QUICK-QUENCH FURNACE

MADE EASIER WITH KNAPP'S 30 YEARS KNOW-HOW!

Manufacturers who have tough production schedules equip their plants with Knapp heat-treating equipment.

They are using them because they are built for SPEED:—Temperature recovery well within established limits. Quench adjustable from 3 to 8 seconds with arrested descent immediately before immersion, thus reducing impact and preventing excessive distortion; EASE OF HANDLING:—assured by floor level loading and unloading; SAFETY:—positive locking devices at floor level and top positions, all operations push button controlled by one operator; ACCURACY:—guaranteed variance of temperature not to exceed plus or minus 5°F in any part of the working zone after stabilization; QUALITY:—uniformly high physical and chemical properties due to the elimination of the human element.

Over 40 Airframe and other Manufacturers in the U.S. and abroad are meeting their production schedules with patented Knapp-Lee Quick-Quench furnaces.



The Knapp reputation for building better equipment is maintained throughout its entire line of standard and custom built furnaces. Knapp has the answer to your heat treating problems. Write today.

JAMES H. KNAPP COMPANY
INCORPORATED
839-841 EAST FOURTH STREET • LOS ANGELES 13, CALIFORNIA

Book Reviews

Here is a typical anecdote. Mr. Churchill is very reluctant to be harried by prolixity. During one interminable debate in the House of Commons, when a speaker was presenting a dramatic list of statistics on Brussels sprouts, Churchill observed an aged member, toward the rear, desperately leaning forward with an old-fashioned ear trumpet. In a voice clearly audible over the House, Churchill said to Anthony Eden, "Who is that idiot denying himself his natural advantages?" He was chided by the speaker—but without visible effect.

You will enjoy this book. There is a chuckle on every page. Churchill has many human failings, but stuffiness is not one of them.—JOHN J. O'CONNOR.

History of Marine Corps Aviation. By Robert Sherrod. Washington, D. C.: Combat Forces Press. 560 pp. $6.50.

WHEN this book came to the editorial offices of ORDNANCE magazine it was assigned at once for review by an expert in the field to which it is devoted. But sometimes editors have a way of thumbing through review copies when they arrive with the result that this volume became sidetracked. Consequently, the review is written by one who has had no experience with Marine Corps aviation. His only claim to the assignment is an abiding and increasing admiration and respect for the United States Marines!

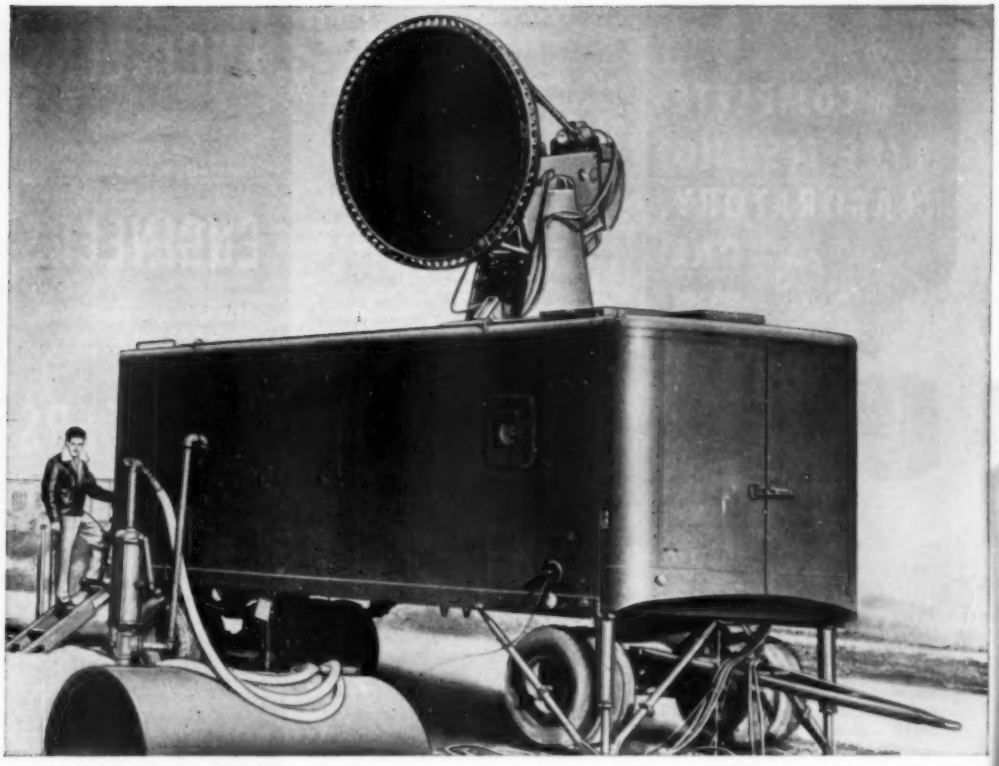
This is the story—and a thriller it is from cover to cover—of the heroic exploits of the one per cent of the U. S. armed forces who served in Marine Corps aviation in World War II. Its accuracy is assured by the fact that the source materials for the volume were gathered by a team of qualified Marine historians who devoted four years of research to the task. All Marine documents and many records from the files of other services, our allies, and the Japanese were available.

The story begins when Marine aviation got under way in 1912 and carries through, step by step, to the beginning of the Korean war in 1950. There are sixty-four pages of photographs and excellent maps.

The Marine Aviation History Board chose Robert Sherrod as author of the book based upon his outstanding performance as war correspondent for *Time* and *Life* and author of the best sellers, "Tarawa" and "On to Westward." As for the powerful story revealed in the text, only the book itself can give an adequate account.

It is especially fitting that this great factual record of Marine Corps Aviation makes its appearance at a time when, by an act of Congress, the Marine Corps itself has been raised to higher recognition in the defense establishment.

If there was ever any doubt that this



It takes PRECISION MANUFACTURING to say "HERE THEY COME"

The big, round screen on top of the mobile trailer, is a radar antenna—part of a new fire-control system for anti-aircraft gun batteries.

Details are classified for security reasons. However, many improvements and refinements, make the device more informative, effective and flexible than its predecessors.

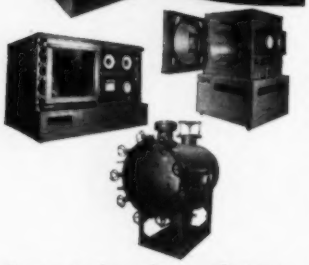
We make the radar antenna and the intricate, precision gears that actuate the system, for the Western Electric Company. Gears that must be precise, because gear errors of ten-thousandths of an inch, mean miles in the sky.

Ours is a record of 37 years of precision design, engineering development and production. Today, 90% of our defense work is in aircraft and ordnance contracts. We help work the miracles of exactness which strengthen the defenses and protect the security of America.

THE STEEL PRODUCTS ENGINEERING CO.

engineers and manufacturers
Springfield, Ohio

now a COMPLETE TYPE TESTING LABORATORY from ONE source



Bowser is the only manufacturer today who can provide a COMPLETE line of type testing equipment, custom engineered to individual requirements. Bowser environmental simulation units meet all MIL, JAN, USAF, AN and other Government specifications for testing equipment.

In addition to a complete range of standard models, Bowser can provide special equipment, with special accessories if necessary, to meet individual requirements of temperature, humidity, altitude, sand and dust etc. Bowser's Engineering staff invites you to take advantage of their long continuous experience, the most versatile in the field.

✓ CHECK AND MAIL TODAY

BOWSER TECH. REFRIG., Terryville, Conn.

Send information on test equipment checked:

☐ High Temperature ☐ Fungus Resistance
☐ Low Temperature ☐ Rain and Sunshine
☐ Temperature Shock ☐ Sand and Dust
☐ Humidity ☐ Immersion
☐ Altitude ☐ Explosion Proof
☐ Walk-In Rooms ☐ Vapor Tight
☐ Special Engineering

Name_____Pos._____
Company_____
Street_____
City_____Zone_____State_____ 9-5

BOWSER
TECHNICAL REFRIGERATION
DIVISION BOWSER INC
TERRYVILLE • CONN

Book Reviews

recognition was due, then read the "History of Marine Corps Aviation" as the latest chapter in the long and inspiring record of the United States Marines.—Leo A. Codd.

Red China's Fighting Hordes. By Lieut. Col. Robert B. Rigg. Harrisburg: The Military Service Publishing Company. 378 pp. $3.75.

MUCH phantasy has been written about Communist China by politicians who have made 30-day junkets in order to qualify as "international experts." But the present volume is a coldly detailed analysis of the factors that make up the army and generals of Red China by an Army officer who spent much time in close contact with the Reds and had the background to understand what he was observing.

When the Marshall plan of appeasement of the Red "agrarian reformers" and withdrawal of American aid to the Nationalists was put into effect in 1945, the Chinese Communists were on the road to complete defeat, driven to the hills of a few northern provinces and no longer able to sustain large-scale guerrilla fighting because of inability to supply the forces on the devastated areas. Today, Red China has an army of not less than three million, well equipped, and with a large reserve of countless hordes of peasants forced to support its rear services.

Two factors make Red China's army a dangerous weapon against the tactical methods of the Western democracies. One is the uncanny ability of the Chinese generals to operate on logistical shoestrings and the endless ability of the Red soldier to forage for himself and endure on few supplies, and the other is the unswerving doctrine of ten casualties to one which they are willing to suffer and believe will win in the end.

Colonel Rigg has detailed much information on the methods, abilities, and weaknesses of the Red soldiers that will be useful to all officers who may have to do battle against them. It is regrettable that this knowledge cannot reach every American to make him realize the nature of our present opponents.

The intimate descriptions of the Red leaders show the ruthless tactics and pitiless brutality which confront us. These leaders can and do use methods that cannot be followed by Western leaders. They recognize no moral values, and promises or treaties need not be kept. The individual has no value except as a tool of the state.

This is not a cheerful book but one that should be read seriously by every American officer. Colonel Rigg ends with the statement that the Red army can be defeated, but he warns that "Mao Tse-tung does not fear long wars nor atomic bombs."—Geo. S. Brady. *(Contd. p. 322)*

ENGINEERS

TO DESIGN, REDESIGN, OR DEVELOP YOUR PRODUCT

ENGINEERS

TO TOOL AND EQUIP YOUR PLANT FOR THE BEST PRODUCTION ECONOMICS

ENGINEERS

TO GET YOUR NEW PRODUCTION GOING AND KEEP IT GOING

ENGINEERS

TO REDUCE YOUR COSTS AND IMPROVE YOUR QUALITY

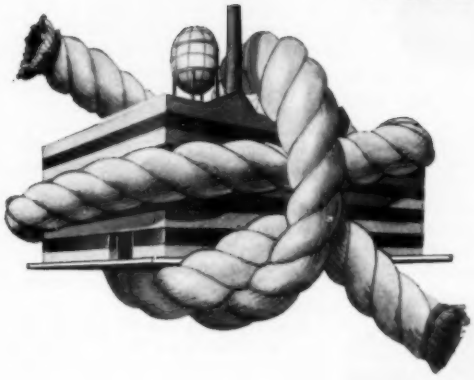
ENGINEERS, DESIGNERS, CONSULTANTS AND PRODUCTION SPECIALISTS

PIONEER ENGINEERING
& MANUFACTURING CO., INC.

19654 JOHN R STREET
DETROIT 3, MICHIGAN

INQUIRIES PROMPTLY ANSWERED

Are you all tied up in defense contracts?



DO YOU WANT TO INCREASE YOUR PRODUCTION FACILITIES?

Pressed Steel Car Company can accept subcontracts for the production of aircraft ground servicing equipment; aircraft and engine component parts; communication equipment; ordnance equipment; structures and component parts; cellular laminated wood products . . . and a wide variety of defense items.

In all, Pressed Steel Car Company has 7 manufacturing divisions and subsidiaries located in Chicago, Buffalo, and Mt. Vernon, Ill. Behind them is over a half century of experience in the manufacture of light and heavy industrial equipment.

Interested?

Contact the Contract Sales Department of Pressed Steel Car Company now.

A PARTIAL LIST OF THE PRODUCTS WE CAN PRODUCE!

Aircraft Ground Servicing Equipment
Dollies-Engine, Propeller & Special Types.
Stands—Maintenance, Servicing

Aircraft Component Parts
Containers—Ammunition, Equipment, Etc.
Engine Mounts & Exhaust System Parts.
Engine Shipping Containers

Communication Equipment
Chassis
Metal Housings

Ordnance Equipment
Launchers
Trailer Component Parts
Trailers

Cellular Laminated Wood Structures
Shelters
Trailers
Containers

Miscellaneous
Liquid Storage Tanks
Fabricated Sheet & Plate Weldments

Cellular Laminated Wood Products
From simple platforms and shipping containers to shelters and railroad cars.

PRESSED STEEL CAR COMPANY, INC.

Contract Sales Department

179 N. Michigan Avenue • Chicago, Illinois

THE RIGHT BALL

Let Strom Help You

Not only in precision ball bearings, but in countless other places, Strom has found that the right ball will do the job better. Maybe your problem can be solved with the use of the proper ball. Why not take it up with Strom.

Strom has been making precision metal balls for over 25 years for all industry and can be a big help to you in selecting the right ball for any of your requirements. In size and spherical accuracy, perfection of surface, uniformity and dependable physical quality, there's not a better ball made.

Strom STEEL BALL CO.
1850 So. 54th Ave., Cicero 50, Illinois
Largest Independent and Exclusive Metal Ball Manufacturer

ALUMINUM EXTRUSIONS

fast deliveries

on A, B, C and E Allotments

Any shape that can be contained in a 6 inch circle. Any length up to 40 feet. Send drawings, specifications and data.

Fabrication facilities available!

We are equipped for aluminum fabrication from extrusion to finished product.

Address Dept. O-9

MICHAEL FLYNN MANUFACTURING COMPANY
700 East Godfrey Ave., Philadelphia 24, Pa.
Telephone FIdelity 2-5500

Book Reviews

Pepperbox Firearms. By Lewis Winant. New York: Greenberg. 188 pp. $5.50.

THIS little volume is an outstanding piece of work. The literature on firearms has lately become so voluminous that one is inclined to consider each new title with somewhat of a jaundiced eye since so many prove, upon inspection, to be strictly "run of mine."

Mr. Winant's book is, however, a pleasing exception. It reveals complete mastery of the subject. His approach is simple and at the same time scholarly. The story unfolds gracefully and leaves practically no nook unexplored. Indeed, the further I got into the text the more I marveled at how any one man could possibly have learned so much about such a specialized segment of small-arms history.

The illustrations (227 of them scattered through 12 short chapters) are splendid and amply implement the narrative. To my astonishment I found not a single typographical slip.

On the critical side, I query the spelling of Shatuck (*sic*), the American arms maker. I have always thought the proper spelling to be "Shattuck."

Other comments of minor moment involve the author's use of "Hall of Archives" in place of the more exact "National Archives" (page 22), and "American Ordnance Bureau" for "Ordnance Department" (page 30).

Topics upon which I would have appreciated some elaboration are the pin-fire pepperboxes in caliber .40 and .51 illustrated in Figures 161 and 161A. I have never found any record of pin-fire pistol ammunition produced in calibers other than 5, 7, 9, 12, and 15 mm., none of which corresponds to caliber .40 or .51, hence my desire for information on these points.

Another item on which Winant might have elaborated is the Devisme pepperbox. If the specimen shown possesses all the characteristics of the one I own (as the cut would suggest) each chamber of this piece is rifled with *one* groove, right twist. Of some thousands that I have examined over the years, this is the only model of weapon with one-groove rifling which I know to exist. The feature is therefore worthy of some remark.

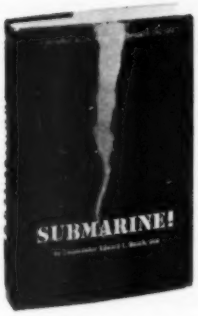
Like all well-researched works the book ends with a bibliography. No topical index is supplied, but the text is so brief that none is really necessary.—CALVIN GODDARD.

Economy in the National Government. By Senator Paul H. Douglas. Chicago: University of Chicago Press. 258 pp. $3.75.

THIS is a very convincing analysis of our inflated government expenditures by

AMERICAN ORDNANCE ASSOCIATION

Book of the Month for September



SUBMARINE!

BY COMDR. EDWARD L. BEACH, U.S.N.

This is the heroic story of the U.S.S. TRIGGER, of the men who sailed her against the enemy, and of her life and death in the Pacific. Commander Beach, a good submariner—and also that rare bird, a good writer—joined TRIGGER before she was commissioned and remained with her until just before her last patrol three years later. In the story of TRIGGER—and of TANG, WAHOO, and other famed submarines Commander Beach tells you about—you find out how it is to serve in submarines in battle. You can feel that fear and uncertainty as you walk in stockinged feet, sweating, while destroyers overhead attack your ship with depth charges; the frustration of pressing home an attack only to see defective torpedoes run wild. You can feel, too, the satisfaction of sending an enemy ship to the bottom with a well-planned attack. "Submarine!" is a great book about a proud service. Retail, $3.50.

To Members, $3.15

VALLEY FORGE

BY ALFRED HOYT BILL

"Valley Forge" is the story of a turning point in American history, more decisive than most people know. During the winter of 1777 Washington had to keep the British penned in Philadelphia and to create a whole new army ready to take the field in the spring—and all this under conditions in which survival was barely possible. Mr. Bill has filled a gap in American history with this account of the creation of the first truly American army. Retail, $3.50. To members, $3.15.

NAPOLEON AT ST. HELENA

THE JOURNALS OF GENERAL BERTRAND

During the last years of Napoleon's life, General Bertrand kept a detailed diary of events and his conversations with the Emperor. This diary, published here in part, is the best portrait in existence of Napoleon as a man. Retail, $3.75. To members, $3.37.

THE NATIVES ARE FRIENDLY

BY JOHN F. LEEMING

Here is one of the funniest tales to come out of World War II. John Leeming was captured with Air Marshal Boyd when their plane crashed in Sicily and was sent to the Italian PW camp for senior officers. The combination of Italian administration and the eccentricities of some British officers turned the camp into something like a comic opera. Retail, $3.00. To members, $2.70.

GEORGE WASHINGTON'S RULES OF CIVILITY

This is the original manuscript of one of George Washington's earliest surviving writings. Copied carefully for his own guidance when he was about 13 years old, this set of maxims for the correct deportment of an eighteenth-century gentleman throws interesting light on the youthful Washington, illuminating his seriousness of character and his painstaking insistence on personal integrity. The quill calligraphy in which the book is written is by Robert Gillam Scott, and the pen-and-ink illustrations are by Leo. S. Stoutsenberger. Retail, $2.50. To members, $2.25.

ORDNANCE BOOK SERVICE
705 Mills Building, Washington 6, D.C.

Gentlemen:
*Please send me, postpaid, the following books:**

1. .....
2. .....
3. .....

Name .....
(please print)

Address .....

City, Zone, State .....

**I certify that I am a member of the A.O.A.*

Special Production Parts In Quantity . . . *Fast*

National Tool Company's 47 years of tooling experience plus the complete facilities listed below assure you minimum reject expense and delivery in accordance with your requirements.

Turning Equipment
- Engine Lathes
- Turret Lathes

Milling Equipment
- Horizontal Milling Machines
- Vertical Milling Machines
- Universal Milling Machines
- Thread Milling Machines

Grinding Equipment
- Cylindrical Grinders
- Internal Grinders
- Surface Grinders
- Thread Grinders
- Face Grinders
- Optical Form Grinders

Drilling Equipment
- Radial Drills
- Drill Presses
- Sensitive Drills

Broaching Equipment

Boring Equipment

Planing and Shaping Equipment

Precision Checking Facilities

Government Certified Heat Treating Department

It will pay you to send us your blueprints for prompt quotations.

National Tool Co.
11295 Madison Ave., Cleveland 2, O.

Book Reviews

a member of the United States Senate who is continuing his efforts to eliminate waste from the vast Federal establishment.

The substance of the book was originally delivered in the form of lectures on the Charles R. Walgreen Foundation at the University of Chicago in October 1951. The text of the lectures has been revised and new material added.

Part I of the book deals with the size, growth, and major areas of Federal expenditure. It describes the budget processes of the Executive Branch and the appropriation procedures of the Congress. The author in no uncertain terms describes the desperate need for economy. Part II of the book discusses waste and nonessential expenditures in both military and civilian areas.

The author indicates ways by which savings of from $7 billion to $7.5 billion can be effected during the fiscal year 1952-1953. In several instances references are made to normal commercial practices, especially in the budget and supply of automotive parts as developed by the Hardy Subcommittee.

Part III of the book discusses ways and means by which revenues can be increased by closing loopholes in the tax laws. Finally, the book concludes with a discussion of practical political problems in achieving a balanced budget.

Senator Douglas, long a student of Federal fiscal operations, was for many years a professor of economics at the University of Chicago. In 1942, at the age of 50, he enlisted as a private in the United States Marine Corps. He participated in the battles of Peleliu and Okinawa. He rose to the rank of lieutenant colonel and was awarded the Purple Heart as well as the Bronze Star for "heroic achievement in action."

Our country is fortunate in having a public servant of his high ideals who is willing to concentrate so much of his public service toward the elimination of waste and the squandering of our substance as has characterized our national conduct in recent years.—Leo A. Codd.

A History of Phelps Dodge, 1834-1950. By Robert Glass Cleland. New York: Alfred A. Knopf. 306 pp. $4.

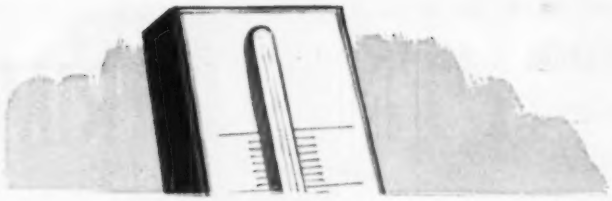
THE mercantile company founded by Anson Green Phelps, and later joined in by his sons-in-law, William Dodge and Daniel James, is well illustrative of the initiative and imagination of the early Yankee trading companies that saw the future of the country in the development of railways, mines, and steamship lines. Much of the book is taken up with the many activities of the company and the men who made it.

In a way it is the romantic story of American trade and industrial progress, and this point is accented by the publishers, but to this reviewer the important value of the book lies in the account of how these men were able to foresee and plan ahead to meet the market needs for copper.

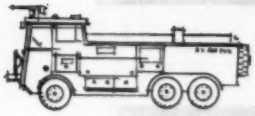
A century ago the annual production of copper in the United States was no more than 2,400 tons, and it was only possible to use ores with a high proportion of copper. As the need for copper grew not only did the search for new ore bodies go on in anticipation of the new markets, but new methods of handling and treating lower-grade ores were devised and millions of dollars sunk in daring enterprises to commercialize them.

The stripping off of 34 million tons of earth and rock at Sacramento Hill in Utah to reach some 9 million tons of ore averaging only 1.7 per cent of copper is only one of many enterprises that showed the engineering and financial daring of this industry. Later, the industry was to develop methods for the utilization of ores with less than one per cent copper—ores which were considered unusable only a few years before.

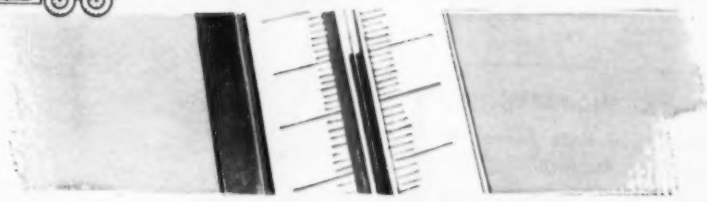
Reading this book gives one the impression that while such "Yankee" enterprise exists the economists of doom will be proved wrong and our metal resources will be developed to meet any emergency. We recommend the book to any one interested in our mineral resources.—George S. Brady.



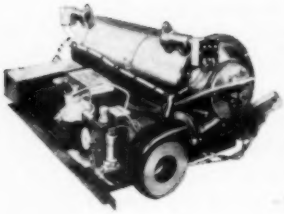
ALL-WEATHER



OPERATION ASSURED



with JANITROL LIQUID HEATERS



It's a cold hard fact that *reliable operation in any weather*—right down to 65° below zero—is a tough spec for any vehicle. But it's a requirement that can be met in full with Janitrol liquid heaters—as severe tests have proved repeatedly. On the USAF bomber tow tug built by Euclid Road Machinery Company, for example, positive starting was accomplished without special fuel capsules at –65°F after a 72-hour cold soak, and engine temperature jumped to the 155° to 165°F range well within 60 minutes.

If you're responsible for protecting investments in any vehicles or stationary engines or mobile power plants, gasoline or diesel powered, you'll do well to look into the 6-year long record of Janitrol liquid heater reliability. Your nearest Janitrol representative is always at your service.

HEAT WHEREVER YOU WANT IT

Janitrol

AIRCRAFT-AUTOMOTIVE DIVISION SURFACE COMBUSTION CORP., TOLEDO 1, OHIO

F. H. Scott, 225 Broadway, New York, N. Y. • C. B. Andersen, 2509 W. Berry St., Ft. Worth, Tex. • L. A. Curtin, 7046 Hollywood Blvd., Hollywood, Calif. • F. H. Scott 4650 East-West Highway Washington, D. C. • Phil A. Miller; Frank Deak, USAF Coordinator, Central District Office, 400 Dublin Ave., Columbus, Ohio • Headquarters, Toledo, Ohio

Whiz

Specification Corrosion Preventive Compounds

for Government Contractors

Specification Number	Trade Name
MIL-C-972, Grade I (Superseding 52-C-18 Grade I)	Klad Kote 101
MIL-C-972, Grade II (Superseding 52-C-18 Grade II)	Klad Kote 122
MIL-C-6708, Type I (Superseding AN-C-52b Type I)	Klad Kote 102
MIL-C-6708, Type II (Superseding AN-C-52b Type II)	Klad Kote 252
AN-C-124a, Type I	Klad Kote 124
AN-C-124a, Type II	Klad Kote 224
AXS-673, Rev. 2	Klad Kote 103
AXS-1759, Grade I	Klad Kote 171
AXS-1759, Grade II	Klad Kote 172
AAF 14156, Amend. 1	Klad Kote 356
USA 2-122	Klad Kote 322
USA 2-121	Klad Kote 221
AN-VV-C-576b, Type I	Klad Kote 376
AN-VV-C-576b, Type II	Klad Kote 378
Light Bodied Slushing Compound (Excellent Water Displacing and Surface Active Qualities)	Klad Kote 365

PACKAGING ENGINEERS!

Newly Revised Klad Kote Reference Chart Now Available

Our newly revised Klad Kote chart, listing the latest specification numbers and specification requirements, will be sent you upon request. This chart includes the type of film, government specification number, product description, uses, application, removal, flash point, and protection requirements. It is an excellent reference for packaging engineers.

Most Klad Kotes are stocked for prompt delivery and are obtainable in 5 and 55 gallon containers. *Quotations furnished on request.*

Partial List of Specification Compounds Which We Can Supply

Corrosion Preventive Compounds: Navy Dept. 52-C-17 (Tat) Amend. I (14-C-6) Grades A, B, and C. – U. S. Army 2-84B – U. S. Army 2-82C – Army Air Force AAF 3604-A.

Anti-Seize Compounds: MIL-C-5544 – JAN-A-669.

Aircraft Cleaning Compounds: Army Air Force AAF 20015-E – Navy Aero C-147.

Non-Inflammable Hydraulic Fluid: Navy BuAer MIL-F-7083

Protective Coating: Army Ordnance AXS-1756 – Navy Ordnance 52-C-44.

Paint Remover: Navy BuAer 52-R-15, Amend. I.

Carbon Removal Compound: Army Air Force AAF X20043-A.

Write: INDUSTRIAL-AVIATION DIVISION

R. M. HOLLINGSHEAD CORPORATION

845 Cooper Street, Camden 2, N. J. Toronto, Ont., Canada

Warehouses:

Dallas San Francisco Chicago

NEW INTRIMIK

Internal Tri-point Micrometer

measures **any** size bore or hole within range of tool... ***without masters***

Now you can realize new economies and speed by measuring bores and holes *directly* with the new Brown & Sharpe Intrimik Internal Tri-point Micrometer. It's a big time and money saver . . . eliminates the need for many expensive plugs and setting rings. Intrimiks measure in increments of .0001" on bore sizes from .275" to .500", and in increments of .0002" on bore sizes from .500" to 4.000". Extensions are available to facilitate measuring deep holes. Write for new illustrated Bulletin. Brown & Sharpe Mfg. Co., Providence 1, Rhode Island, U.S.A.

WE URGE BUYING THROUGH THE DISTRIBUTOR

B·S

Brown & Sharpe

ORDNANCE MEN

don't wait for Miracles!

Underwood and Underwood

— because ORDNANCE MEN know that miracles don't "happen!" They know each day is numbered, that each day's passing means one day less to get America ready!

— entrusted with some $1 Billion a month throughout industry, these key-industrialists have time only for most selective reading BUT—

they do read ORDNANCE more thoroughly than any other technical journal!

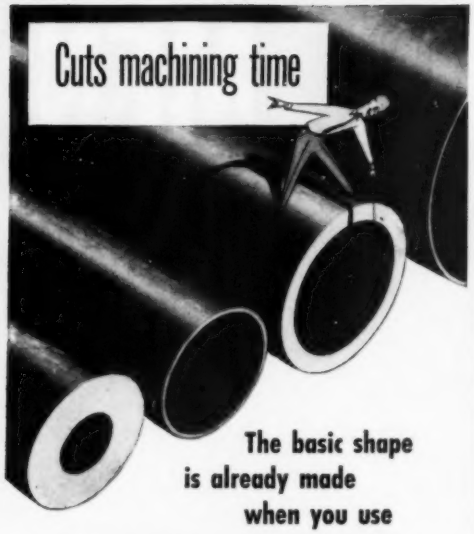
If you're looking for men who make decisions, you'll find them . . . reading ORDNANCE!

ORDNANCE READERS ARE KEY MEN IN INDUSTRY

Thomas O. Woolf & Son Company

70 East 45th Street, New York 17, N. Y.
Los Angeles San Francisco

932-1



The basic shape is already made when you use

SHELBY SEAMLESS

● You can do practically anything with a tube that you can do with a solid round bar—and you save the cost of the hole.

Thousands of machine shops take advantage of this fact and produce high quality machined parts at savings up to 50% with the aid of Shelby Seamless Mechanical Tubing.

Boring and extensive machining can be minimized —sometimes eliminated—with Shelby Seamless. You save time, labor, materials, as well as wear and tear on expensive tools. You can often select just the right tube for your job, because Shelby Seamless is made in so many sizes, wall thicknesses, steel grades and finishes. Some shops find they can simply cut the tube to length, and with a clean-up finishing operation, the job is through.

When you get into *volume* production, it's reassuring to know that with Shelby Seamless, uniformity can be taken for granted, due to our tightly controlled manufacturing process. Whether you make one part, or hundreds or tens of thousands, this dependable uniformity makes it possible to closely estimate your time, labor and material.

Our engineers will be glad to help you utilize the many advantages of Shelby Seamless for your product. Meantime, send for our free Bulletin Number 17. It may help you cut time and costs—and make a better product in the bargain.

All National Seamless Tubing is pierced from solid billets of uniform steel—the one manufacturing method that assures uniform wall strength.

NATIONAL TUBE DIVISION, UNITED STATES STEEL COMPANY
PITTSBURGH, PA.
(TUBING SPECIALTIES)
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

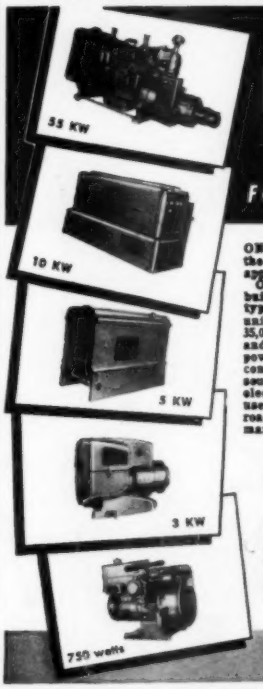
U·S·S SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

8-Power Prism Monocular

For
over 40 years
Makers of Optics
Optical Instruments
Fire Control Devices
Mechanisms of Precision

Kollmorgen Optical Corporation
2 Franklin Ave., Brooklyn 11, N. Y.
Plants at Northampton, Mass., and Brooklyn, N. Y.



ONAN BUILDS
ELECTRIC PLANTS
FOR EVERY NEED!

ONAN builds electric plants to meet the requirements of any military application.

Onan gasoline-powered plants are built in a wide range of sizes and types from lightweight, portable units (400 to 5,000 watts), up to 35,000-watt models for heavy duty and emergency use. Onan Diesel-powered plants are designed for continuous service as a primary source of electric power. Special electric plants adapted for military use and in industries such as railroads, airlines, construction, radio, marine, and oil fields are available.

ONAN ELECTRIC PLANTS

A.C.: 400 to 55,000 watts, all standard voltages and frequencies. D.C.: 750 to 15,000 watts, 115 and 230 volts. Battery Chargers: 400 to 3,500 watts, 6, 12, and 32 volts. Also Onan 400-cycle motor-generator sets—1½ to 20 KW, one and three phase.

Write for FOLDER!

D. W. ONAN & SONS INC.
7608 University Avenue, Minneapolis, Minnesota

Onan PRODUCTS

do the job *RIGHT HERE!*

Abbott Bearing Balls, used as a valve in millions of grease fittings, do their part to keep *civilian* and *military* transport equipment effectively lubricated. Every Abbott Ball—DEEP HARDENED with a mirror-like glass hard finish—is shock resistant and performs efficiently under high load factors. Use Abbott... *the all round ball.* Abbott Catalog-*N* annual contains full information on ball sizes and uses. Write for it.

ABBOTT

THE ABBOTT BALL COMPANY
70 Railroad Place, Hartford 10, Conn.

Cork-and-Rubber Gasket Materials

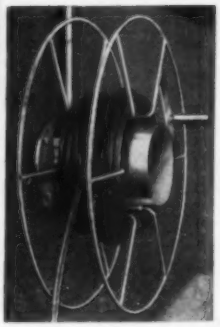
Armstrong manufactures cork-and-rubber gasket materials made to meet each class of the principal government specifications covering cork-and-rubber gasket materials.

Specification	Material
MIL-G-6185	
Type I Soft	NC-709
Type I Medium	NC-710
Type I Firm	NC-711
MIL-T-6841	DK-153 / RK-504S
Type II Soft	DC-167
Type II Medium	DC-100
Type II Firm	DC-113
MIL-G-6747	DK-149

Write for samples and 24-page gasket design manual.

ARMSTRONG CORK COMPANY
2905 Arch St., Lancaster, Pennsylvania

For Easier Handling of Electrical Cables

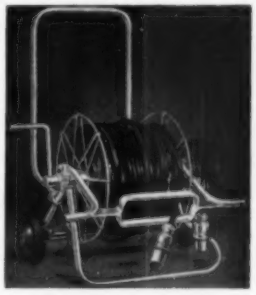


Wall-Mounting POWEREEL
for Permanent Applications

Easily mounted on trucks, walls, any surface, for heavy cables. May be connected to conduit or feeder cable. Available with stand for portability. Can be equipped with bevel gear drive for outside cranking when mounted in recess or compartment in side of truck—or with spring retractable mechanism. Has standard Collector Ring up to 16 conductors.

POWEREEL
for Portable Uses

Eliminates "rassling" with long heavy cables. Reduces wear. Available with or without cable, wheels, handle. Has friction brake, lock—also standard Collector Ring up to 16 conductors. Reel—12" wide, 16" in diameter. Weight—21 pounds less cable and plugs.



PORT-O-REEL
for Long Cords

Prevents kinks, knots. Furnished with or without cord or hand lamp. Has screw binding posts for attaching any cord, 30 amp Collector Ring and is available with microphone cords and standard plugs. Offers 1001 uses for all industries. Weight—9 pounds less cable and plugs. Reel—4" wide, 12" diameter.

COLLECTOR RING
for General Purposes

Designed for slow speed operation on special machinery and equipment requiring rotating electrical contract. Standard rings fit 1½" shaft. Furnished with driving collar equipped with set screws. Rings for any application can be designed, built to specs.

Any of the above reels can be modified. Or special reels for any industry or Armed Service can be built to specifications. Let us quote you on prices and delivery. Write:

INDUSTRIAL ELECTRICAL WORKS
Dept. 0-9
1511 Chicago Street — Omaha, Nebraska

WE BELIEVE THAT A STRONG AMERICA IS A PEACEFUL AMERICA

MASON & HANGER COMPANY
SILAS MASON COMPANY

ENGINEERS
and
CONTRACTORS

Builders and Operators of
Ordnance Facilities

OFFICES:

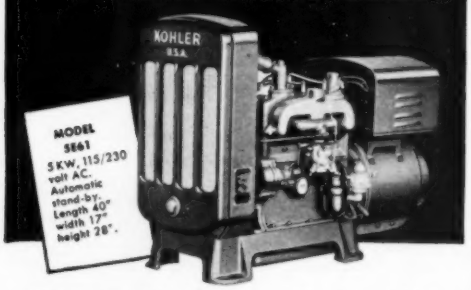
500 Fifth Avenue
New York

Shreveport
Louisiana

Lexington
Kentucky

KOHLER ELECTRIC PLANTS

Independent Source of Electricity



Kohler Electric Plants provide a portable, mobile, reliable source of light and power for military needs. In sizes from 350 watts to 15 KW. Also stand-by models for emergency service. Write for folder 25-F.

Kohler Co., Kohler, Wisconsin. Established 1873

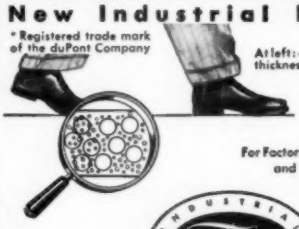
KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
AIR-COOLED ENGINES • PRECISION CONTROLS

NEW! fulltred® Floor Wax with Ludox*

Slipping Retarded with Ludox* Colloidal Silica in FULLER'S New Industrial Floor Wax

* Registered trade mark of the duPont Company



At left:—Wax film of approx. .0001" thickness, magnified 200,000 times to show how your feet press "Ludox" spheres into the larger wax particles.

For Factories, Institutions and Buildings

3585 MAIN STREET — INDUSTRIAL Fuller BRUSH CO. DIV. — HARTFORD 2, CONN.

Fullergript, Wet and Dry Mops, Brooms, Floor and Special Brushes.

ARE DRIVERS "RAILROADING" YOUR VEHICLES?

Handy Governors Will Stop It

Any driver is likely to be less than meticulous in his care of a vehicle he doesn't own. Many feel no compunction about "railroading" your vehicles. Drivers do most of their work away from supervision . . . abuses are hard to correct.

Handy Governor will stop "railroading"—stop practices which run up costs and wear out vehicles before their time.

The savings in tire, fuel, and lubricant costs, engine repairs, brake maintenance and general maintenance are spectacular. Reduced accident and insurance costs are equally important.

Let us show you some figures on savings—and tell you how little it costs to get them.

KING-SEELEY CORPORATION
ANN ARBOR, MICHIGAN
PLANTS AT ANN ARBOR, SCIO, YPSILANTI

Heavy Duty Checkweighing Scale for Cartons & Bags . . .

Here is a new EXACT WEIGHT Scale designed for checkweighing filled bags and cartons. Handles any type container coming down conveyor line after the filling machine. Each package is weighed; correct containers going to the closing machine, over and underweight packages are removed for trimming. Features are (1) checkweighs each package (2) fits into any production line (3) illuminated dial that warns operator when filling machine adjustments should be made, (4) standard capacity to 100 lbs, more weight if needed. This is ideal equipment for checkweighing all types of products going into cartons and bags. For full details write for circular covering EXACT WEIGHT Scale Model #1302-R.

EXACT WEIGHT SCALES
Industrial Precision
THE EXACT WEIGHT SCALE COMPANY
900 W. Fifth Avenue COLUMBUS 8, OHIO
2920 Bloor St. W., TORONTO 18, CANADA

CLEVELAND CONTAINERS

PROVEN PERFORMANCE backed by our long experience in ORDNANCE PACKAGING to your Service Specifications.

Consult us on SPARE PARTS PACKAGING for protection in handling and in transit.

CONTAINERS of proven quality for Ammunition, Signal Flares, Spark Plugs, and endless other special applications.

PLUGS and SLEEVES to protect threads. SPECIAL TUBING for protection against rust and corrosion.

• • •

We serve the United States and Canada. For quick action, consult our nearest plant.

The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO
• All-Fibre Cans • Combination Metal and Paper Cans
• Spirally Wound Tubes and Cores for all Purposes
PLANTS AND SALES OFFICES: Cleveland, Detroit, Chicago, Plymouth, Wisc., Jamestown, N. Y., Ogdensburg, N. Y. • ABRASIVE DIVISION at Cleveland SALES OFFICES: Grand Central Terminal Bldg., New York City; Washington Gas Light Bldg., Washington, D. C.; West Hartford, Conn.; Rochester, N. Y. Cleveland Container Canada, Ltd., Prescott, Ontario • Offices in Toronto and Montreal

ONCE AGAIN

the experience, skill and facilities of Burgess-Norton are at work in the production of parts vital to our rearmament program.

In World War II Burgess-Norton played a major part in the development and production of tank track links and blocks.

Since that time our development engineers have been constantly redesigning these track parts to keep pace with the many improvements and design changes in America's tanks. Today we are again in production of new, improved tank links and blocks to meet the expanded requirements of the new tank program.

5448

McCORD

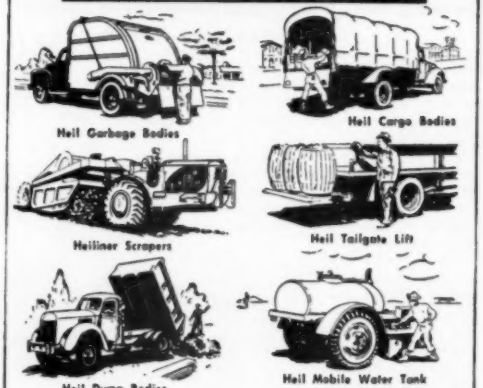
Suppliers to the ARMY – NAVY – AIR FORCE

CIVILIAN PRODUCTS

Automotive Radiators and Gaskets, Refrigeration and Air Conditioning Condensers, Mechanical Force Feed Lubricators and Unit Heaters.

McCORD CORPORATION • Detroit 11, Mich.

Heil Service Veterans



Manufactured By

HEIL Quality Products

THE HEIL CO.

GENERAL OFFICES • MILWAUKEE 1, WISCONSIN

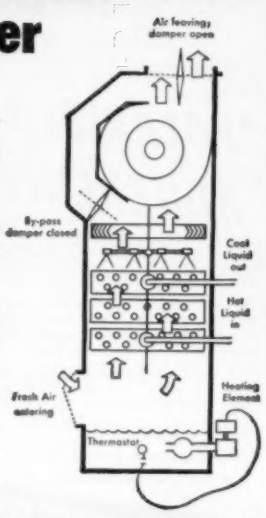
Send For Complete Catalog

NIAGARA Aero Heat Exchanger

1. Extends quenching capacity without extra water or cooling tower.
2. Quickly pulls down heat at initial peak load of Quenching.
3. "Balanced Wet Bulb" Control holds quench bath at proper temperature, heating if needed to start after shut-down, and cools or heats by automatic control.
4. Saves cleaning expense as compared to cooling tower which picks up acids and fumes from air.

APPLICATIONS

Quench Oils
Cutting Oils
Lubricating Oils
Cooling Water



For help in increasing production, saving of cooling water, write for Bulletin No. 120. Address

NIAGARA BLOWER COMPANY

Over 35 Years of Service in Industrial Air Engineering

Experienced District Engineers in Principal Cities of U. S. and Canada

Dept. O, 405 Lexington Ave. New York 17, N. Y.

USE PREP PRODUCTS!

TO MEET GOVERNMENT SPECS.

MIL-C-10578 JAN-C-490
MIL-C-5541 USA-57-02C

For other Gov't Specs. write for Specification Data Sheet

Prep-n-Cote
Multi-Purpose, Corrosion-Resisting, phosphate coating and cleaning product for mechanical cleaning systems . . . Described in Prep-n-Cote Bulletin 48-91.

Metalprep
General all-purpose Rust Remover and Metal Cleaner, available in wipe-off and dip type grades . . . Described in Metalprep Bulletins 50-34 and 50-37.

Lyfanite
Corrosion-proof Coating for Aluminum Alloys, providing thousands of hours of salt spray and humidity resistance . . . Described in Lyfanite Bulletin 49-98.

Galvaprep
Provides greater paint adhesion on Galvanized Iron, Galvanneal and other zinc-coated surfaces . . . Described in Galvaprep Bulletin 48-89.

"PREP PRODUCTS Used First . . . Make Your Paint Finish Last"

Prep-pik-l
Heavy Rust and Light Scale Remover; non-corrosive on surrounding equipment . . . Described in Prep-Pik-L Bulletin 49-3.

Rust-prev
Economical process to preserve Ferrous Metals from rusting during fabrication and interim storage periods . . . Information on request.

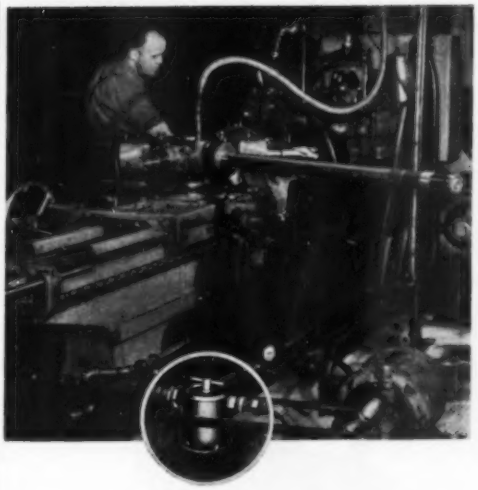
Alumiprep
General all-purpose Metal Conditioner for Aluminum Alloys, available in wipe-off and dip grades . . . Described in Alumiprep Bulletin 50-62.

Emulsoprep
Emulsion and Alkaline Metal Cleaners, available for all types of metals and applications, dip or spray . . . Described in Emulsoprep Bulletin 50-61.

. . . and General PREP Bulletin 48-60

NEILSON CHEMICAL COMPANY

3602 Tecumseh Rd. Windsor, Ont. — 6380 BENSON ST., DETROIT 7, MICH. — 3411 Union Pacific Ave. Los Angeles 23, Calif.



Remove Iron and Steel Particles from Coolants & Lubricating Oils with the FRANTZ Magnetic Separator

FERRO FILTER

You get longer tool life, more production, reduced maintenance

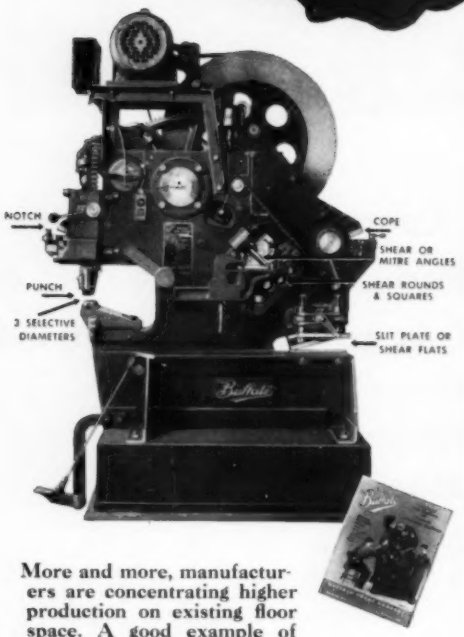
This permanent magnet filter, installed in the lines circulating coolants, lubricating and hydraulic oils cuts tool regrinding; contributes to finer finishes of machined and ground parts; and protects all wearing surfaces. Can be mounted in any position—horizontal, vertical or on an angle. Rate of flow from 5 to 200 gpm. For more complete information . . .

Send for BULLETIN 51

S. G. Frantz Co., Inc.
P. O. Box 1138 Trenton 6, N. J.
Manufacturers of Permanent Magnet and Electromagnetic Separators

"Buffalo" Tips on Metal Working

WHY BUY 5 MACHINES WHEN 1 WILL DO THE JOB?



More and more, manufacturers are concentrating higher production on existing floor space. A good example of this is the "Buffalo" Universal Iron Worker shown. Without tool changes, this fast, rugged machine does up to FIVE operations. Takes the space of ONE machine. Does it save time? One shop's Universal Iron Worker now does in ONE HOUR fabrication that took ONE DAY by other methods. WRITE FOR BULLETIN 360E NOW for complete information on the 7 sizes and 5 styles to choose from—for LOWER COST FABRICATION!

"Buffalo" MACHINE TOOLS

BUFFALO FORGE COMPANY

534 Broadway BUFFALO, NEW YORK

75 YEARS

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

DRILLING PUNCHING SHEARING CUTTING BENDING

Specify **HOUGHTON**

THE RUST PREVENTIVES WITH

"POLARIZED ADHERENCE"

TO METALS—INDOORS OR OUT!

A special process produces "polarized adherence"—a sort of magnetic attraction—that makes the new type of Houghton rust preventives cling to metals until cleaned off.

That's why, when properly selected, they give you positive protection for either short or long term exposures, indoors or out.

There's a "Cosmoline" or "Rust-Veto" for every purpose. Get bulletin from E. F. Houghton & Co., Philadelphia 33, Pa.

COSMOLINE widely used to meet GOVERNMENT "SPECS."

RUST-VETO popular for general INDUSTRIAL USES

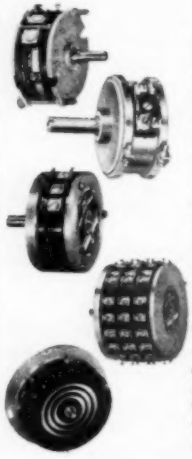
RUST-VETO and COSMOLINE ... products of

E. F. HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

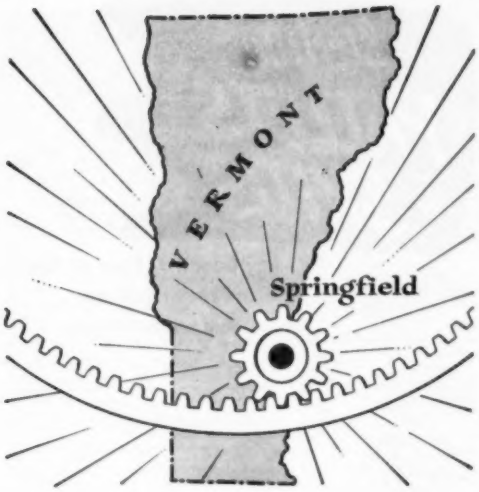
For Your Control Applications



Where accuracy is needed in industrial control applications, Fairchild precision potentiometers give outstanding performance. These units perform mathematical computations in electrical computing systems for machine-tool controls, aircraft instruments, aerial camera controls, radar, guided missiles, gunsights, and analog computers of all types. They are available in non-linear and linear types and in ganged combinations of both, with windings to meet your requirements. For recommendations concerning your computer or control problems, send your requests to *Potentiometer Division, Fairchild Camera and Instrument Corporation, Park Avenue, Hicksville, L. I., New York, Department 140-25G*

FAIRCHILD

PRECISION POTENTIOMETERS



CENTER OF GEAR 'Know How'

Nestled in the green hills of Vermont, is "centered" a group of men who know gears and their applications. Those having gear problems will find Fellows ready and able to give an engineering 'assist'.

Their contribution flows from a fund of more than 50 years cumulative experience in solving the design and application problems of precision gears pertaining to all types of ordnance.

Fellows in addition manufactures a complete line of equipment for cutting, finishing and testing gears.

Fellows

THE FELLOWS GEAR SHAPER COMPANY
Head Office and Export Department, Springfield, Vermont.
Branch Offices: 323 Fisher Bldg., Detroit 2 • 5835 West North Avenue, Chicago 39 • 2206 Empire State Bldg., New York I.

METALWORKING MACHINERY

Cold Headers for Bolts, Screws, etc.

Bolt Head Trimmers

Screw Thread Rolling Machines

Nut Forming Machines

Nut Tapping Machines

Screw Slotters

Rivet Drillers

Power Presses of all Kinds

Eyelet Machines

Small Arms Ammunition Machines

Collapsible Tube Machines

Thread Rolling Machines for Shells

Wire Drawing Machines

Rolling Mills for Sheets and Strips

Rod and Tube Mills

Flatteners and Straighteners

Gang Slitting Machines

Swagers, Pointers, Coilers, Winders, etc.

Special and Miscellaneous Machines

WATERBURY FARREL
FOUNDRY AND MACHINE COMPANY
Waterbury Connecticut, U. S. A.
SALES OFFICES:
CHICAGO CLEVELAND MILLBURN, N. J.

STAMPINGS

ANY SIZE • SHAPE • THICKNESS • ANALYSIS

THIS NEW PRESS IS IDEALLY SUITED FOR THE PRODUCTION OF STAMPINGS SUCH AS—

MILITARY
- Bomb Fins
- Gun Mount Components
- Bomb Skins
- Breech Covers
- Rocket Components
- Pontoons
- Radar Reflectors
- Casket Components
- Motor Vehicle Parts
- Landing Mats
- Track Guides
- Jettisonable Fuel Tanks
- Guided Missiles

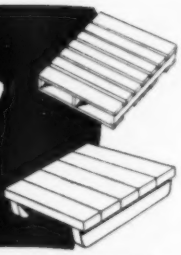
AUTOMOTIVE
- Bumpers
- Hood Lock Plates
- Stone Deflectors
- Rocker Panels
- Instrument Panels
- Cross Members
- Reinforcements
- Bumper Guards
- Grilles
- Oil Pans
- Cylinder Head Covers
- Engine Plates

ASK FOR DETAILS ON MODERN LEAKE STAMPING TECHNIQUES NO OBLIGATION.

Look to **LEAKE** for *unusual* metal stampings

THE LEAKE STAMPING COMPANY
MONROE, MICHIGAN

Sterling PALLETS & SKIDS



Any Quantity, Type or Size
Prompt Delivery
Competitive Prices

✓ SPECIAL CRATE SERVICE

Increasing numbers of manufacturers are taking advantage of our complete crating service—Design, Engineering and Manufacture to exact requirements. Complete details on request. Ask today.

There's a reason why Sterling Pallets and Skids give longer, more satisfactory service—they're built better—of sound lumber and carefully inspected to insure compliance with *our* high standards before they leave our fabricating plant at Goodwater, Alabama.

Next time you need pallets or skids of any type—a call to PULlman 5-0220 will bring a Sterling Engineer to your desk with evidence of Sterling superiority. Try it . . . there's no obligation.

PHONE **PU 5-0220**

Sterling
LUMBER & SUPPLY COMPANY
11908 S. Halsted St., Chicago 28, Ill.

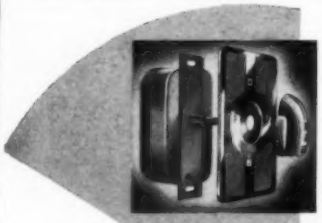
GOVERNMENT FINISH SPECIFICATIONS

and the Parker Products which meet them

SPECIFICATION	PARKER PRODUCTS
AXS 1245	(See JAN-C-490)
JAN-C-490, Grade I	Bonderite 100, 125, 140, 160, 170, 180
JAN-C-490, Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
JAN-F-495	Bonderite 32, 34, 100, 125, 140, 160, 180
JAN-L-548	Parco Compound, Parco Powder
MIL-10578 (Formerly U. S. A. 3-213)	
Type I	Parco Cleaner 250
Type II	Parco Cleaner 260
MIL-C-5541	Bonderite 700
MIL-C-16232 (BuOrd)	
Type I	Parco Lubrite 1, 2, 3
Type II	Parco Compound
Naval Aeronautical M-364	Parco Compound—Parco Powder
QQ-P-416 Type III	Bonderite 32, 34
U. S. A. 57-O-2	
Type II, Class A & A1	Parco Lubrite 1, 2, 3
Type II, Class B	Parco Compound—Parco Powder
Type II, Class C	Bonderite 100, 125, 140, 160, 170, 180
U. S. A. 72-53	Bonderite 32, 34, 100, 125, 140, 160, 170, 180

For information regarding these or other specifications write:

PARKER RUST PROOF CO. 2165 E. Milwaukee Detroit 11, Michigan



MARK-TIME 9000-SERIES WALL TIME SWITCH
Time ranges from 3 minutes to 12 hours.
Rated at 20 amperes, 125 volt or 10 amperes, 250 volt, 1 HP operation. AC only. Available for either ON type or OFF type operation.

mark-time wall time switch
gives current saving convenience

Easily mounted in any standard rectangular wall box, this rugged, dependable Mark-Time time switch automatically controls the electrical circuit controlling attic fans, store window lights, hall and garage lights, farm lighting systems and neon signs, etc. . . .
Movements only are available for use in connection with home or factory heating control.
Write for further details and prices.

first where quality counts

MARK-TIME **M. H. RHODES, INC.**
HARTFORD, CONNECTICUT

In Canada send inquiries to Sperry Gyroscope Ottawa Limited Ottawa, Ontario, Canada

Index of Advertisements

SEPTEMBER-OCTOBER, 1952

The following companies have shown by their interest in the Industry-Ordnance Team that they are ready to serve the United States through industrial preparedness for national security and peace. Such companies as these are indicative of the industrial strength of the Nation upon which the military might of the armed forces depends in peace and war. Their production for the peacetime needs of America can be converted to meet national requirements in an emergency.

	Page
Abbott Ball Company	329
Advance Die & Tool Company	201
Aerial Products, Inc.	307
Aetna-Standard Engineering Company	312
Allis-Chalmers Manufacturing Company	184
Allison Division, GMC	198
Aluminum Company of America	188
Alvey Ferguson Company	296
American Chain & Cable Company	234
American Chemical Paint Company	304
American Locomotive Company	221
American Machine & Foundry Company	305
American Steel Foundries	196
Ansul Chemical Company	292
Arma Corporation	217
Armstrong Cork Company	329
Arnold Engineering Company	210
Avco Manufacturing Corporation—Lycoming Divisions	313
Barium Steel Corporation	180
Barnes Company, W. F. and John	214
Bassick Company	202
Beaird Company, J. B.	226
Bell Telephone Laboratories	194
Bendix Aviation Corporation	218, 224, 229, 295
Bendix-Westinghouse Automotive Air Brake Company	179
Binks Manufacturing Company	308
Blaw-Knox Company	189
Bohn Aluminum & Brass Corporation	II Cover
Bowser, Inc.	320
Breeze Corporations, Inc.	211
Brown & Sharpe Manufacturing Company	326
Buffalo Forge Company	334
Bundy Tubing Company	213
Burgess-Norton Manufacturing Company	332
Buschman Company, E. W.	316
Cannon Electric Company	306
Caterpillar Tractor Company	192
Chase Brass and Copper Company	209
Chrysler Corporation	185
Clark Equipment Company	197
Cleveland Container Company	331
Continental Motors Corporation	187
Danly Machine Specialties, Inc.	287
Delaware River Port Authority	200
Delco Radio Division, GMC	291
Dempster Brothers, Inc.	204
Denison Engineering Company	208
Du Pont de Nemours & Company, E. I.	IV Cover
Eastern Tool & Manufacturing Company	Facing 305
Eaton Manufacturing Company	195, 301
Elastic Stop Nut Corporation	181
Exact Weight Scale Company	331
Fairchild Camera & Instrument Corporation	334
Fairchild Engine & Airplane Corporation	309
Fellows Gear Shaper Company	335
Flynn Manufacturing Company, Michael	322
Frantz Company, S. G.	333
Fruehauf Trailer Company	338
Fuller Brush Company	330
Gits Brothers Manufacturing Company	186
Glidden Company	215
Gray Manufacturing Company	178
Great Lakes Steel Corporation	203
Heckethorn Manufacturing & Supply Company	216
Heil Company	332
Heppenstall Company	222
Hollingshead Corporation, R. M.	326
Houghton Company, E. F.	334
Industrial Electrical Works	329
International Harvester Company	311
International Nickel Company	315
Kelsey-Hayes Wheel Company	289
King-Seeley Corporation	331
Knapp Company, James H.	318
Kohler Company	330
Kollmorgen Optical Company	328
Koppers Company	233
Leaks Stamping Company	336
Link-Belt Company	212
Luria Engineering Corporation	285
Magnetic Metals Company	237
Markem Machine Company	301
Mason & Hanger Company	330
McCord Corporation	332
Metallizing Company of America	288
National Breech & Machine Company	205
National Malleable & Steel Castings Company	294
National Tool Company	324
Neilson Chemical Company	333
Niagara Blower Company	333
O & S Bearing Company	236
Oakite Products, Inc.	183
Olin Industries, Inc.	295
Oliver Corporation	317
Onan & Sons, Inc., D. W.	328
Optical Gaging Products, Inc.	239
Parker Rust Proof Company	336
Perfection Stove Company	225
Pioneer Engineering & Manufacturing Company	320
Pittsburgh Plate Glass Company	219
Potter Instrument Company	298
Precision Castings Company	227
Pressed Steel Car Company	321
Remington Arms Company	314
Remington Rand Inc.	283
Reo Motors, Inc.	182
Reynolds Metals Company	228
Rhodes Company, M. H.	336
Rockwell Manufacturing Company	310
Rolock, Inc.	282
Shafer Bearing Corporation	284
Sheffield Corporation	207
Silent Glow Oil Burner Corporation	231
Simonds Abrasive Company	290
Smith Paper Company, H. P.	206
Sperry Gyroscope Company	303
Spicer Manufacturing	Facing 208, 209
Standard Steel Spring Company	190
Standard Tube Company	238
Steel Products Engineering Company	319
Sterling Lumber & Supply Company	336
Strom Steel Ball Company	322
Sun Electric Corporation	237
Superior Foundry, Inc.	300
Surface Combustion Corporation	325
Timken-Detroit Axle Company	220
Timken Roller Bearing Company	III Cover
Tube Reducing Corporation	235
Tubing Appliance Company	302
Underwood Corporation	286
United Chromium, Inc.	230
United Engineering and Foundry Company	Facing 304
U. S. Steel Company—National Tube Company	328
Waldes Kohinoor, Inc.	293
Waterbury Farrel Foundry & Machine Company	335
Watson-Stillman Company	232
Wirebound Box Manufacturers Association	299
Wolverine Tube Division	193

ORDNANCE *is set up, printed, and bound for the American Ordnance Association by the William Byrd Press, Inc., Richmond, Va.*

IT LOOKS LIKE AN ORDINARY CARGO TRAILER . . .

But It's a Tough, Cross Country Military Unit

THIS SPECIAL Army Ordnance unit is as tough and reliable as the men it serves beside. Designed for loads of 3,000 pounds at speeds up to 30 mph on all kinds of rolling terrain and unimproved trails, the Military Cargo Trailer will also carry loads up to 5,000 pounds at 50 mph on prepared roadways. Snorkle-equipped brakes permit fordings and swamp-country service.

Over 30,000 of these Military Cargo Trailers, developed in co-operation with Army Ordnance, are being built in Fruehauf's 783,700 square-foot manufacturing plant at Avon Lake, Ohio, on a precision-production line right alongside Fruehauf's regular civilian Trailer line. This two-fold contribution to defense—military units for field service, and regular freight units for the nation's industrial economy—is going on at all of Fruehauf's seven American plants.

159 sub-contractors, located in 14 states, share in the supply of materials for the Military Cargo Trailer, and their combined orders represent 73.7% of the total sum of the contract. 108 of these sub-contractors are classified as *small* businesses.

Fruehauf designed 126 different types of military Trailers during World War II. This fund of engineering experience, and Fruehauf's complete Trailer manufacturing facilities — most extensive in the world — are again available to serve America!

FRUEHAUF Trailers
"ENGINEERED TRANSPORTATION"

World's Largest Builders of Truck-Trailers

FRUEHAUF TRAILER COMPANY
Detroit 32, Michigan

TRUCK-TRAILERS FOR EVERY CIVILIAN AND DEFENSE HAULING NEED!

ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

The Projectile in Flight

Effects of Eccentric Wall Thickness on Shell Behavior

Col. H. U. Wagner

DURING World War II (and no doubt today) manufacturers of high-explosive artillery projectiles involuntarily accumulated scrap piles of projectiles which failed to meet the specifications or the dimensional requirements of the drawing and were rejected.

Variations Annoying

Of all the dimensional requirements which must be met, those on variation of wall thickness are perhaps most annoying. Notwithstanding the fact that the tolerance on these variations are in the order of hundredths and not thousandths of an inch, the need for even this degree of accuracy has been questioned. The reasons are continually asked why the tolerance should not be liberalized so as to pass those just over the border.

The requirements as to minimum strength of material are readily appreciated as the projectile must withstand firing stresses in the gun. The reasons for the relatively close tolerance on over-all weight of projectile are well understood. One cannot throw a tennis ball as far as he can an orange of the same size. Wherever exact fits are involved the need for close tolerances is obvious.

But in cases where fits are not involved, such as in over-all length or wall thickness, it has been argued that a minimum should be set, the maximum being governed only by the weight tolerance.

As the result of long experience, the prescribed tolerances on outside dimensions of modern projectiles are consistent with their respective weight tolerances. If, during machining, the centering operations are not carefully checked, it is quite possible to produce a projectile whose weight is within the weight tolerance, whose inside and outside dimensions fall within the prescribed limits, but whose cavity is eccentric or elliptical resulting in variations in wall thickness beyond those permitted by specifications.

CONTENTS

ARMAMENT TECHNOLOGY SECTION

The Projectile in Flight 339
Col. H. U. Wagner
Some effects of eccentricity

Helicopter Maintenance 346
Col. William B. Bunker
A better system is needed

Dependable Ordnance 350
Vernon M. Korty
A problem with complex devices

It is quite natural for a manufacturer who has had projectiles rejected solely on this account by a small margin (one or two hundredths of an inch), to request additional tolerance.

To determine by actual firing tests the quantitative change in the probable errors of all the standard high-explosive projectiles which might result by increasing the tolerance on variation of wall thickness by one one-hundredth of an inch would be a long and difficult task, and its cost would be prohibitive.

Rapid Spin

When the modern high-explosive, spin-stabilized projectile (Fig. 1) is fired from the gun, it is spinning rapidly around its long axis. For example, a projectile when fired from a 3-inch gun whose twist of rifling is one turn in 40 calibers (120 inches), leaves the muzzle of the gun spinning at the rate of 16,800 revolutions a minute. If the twist of rifling were one turn in 25 calibers, the spin would be about 26,000 revolutions a minute.

The spin is imparted to the projectile in order to stabilize it in flight. A projectile is said to be stable in flight when its long axis turns gradually so as to keep the axis pointing toward the direction of air resistance. When the axis is pointing directly into the "oncoming" air, as illustrated in Figure 2, the mini-

mum cross-sectional area is presented, and the retardation of linear velocity is minimum.

When the axis is not pointing directly into the oncoming air, as illustrated in Figure 3, a greater area of resistance is presented. The resulting retardation in velocity is greater in this case. The projectile is said to be flying with yaw. In Figure 3, if *AB* represents the direction of the oncoming air and *RR'* the long axis of the projectile, then *DRR'* is the angle of yaw. The greater the angle of yaw the greater the retardation of linear velocity.

Two means are presently used to stabilize projectiles in flight. In guns, howitzers, and high-velocity mortars, spinning is employed. In low-velocity mortars, fins are attached to the rear part of the projectile, and the fin-stabilized projectile flies much like an arrow.

Effect in a Vacuum

If a high-explosive artillery projectile could be fired in a vacuum, the only external force acting upon it would be gravity. If it were spinning around its long axis the axis would maintain the same direction all during flight, and the projectile would land with its long axis pointing in identically the same direction as when it left the gun.

The path of the projectile in a vacuum is a parabola lying wholly in the vertical plane. The path of the projectile is called the trajectory.

There being no forces other than gravity to retard the flight of a body in a vacuum, the horizontal distance which a body would travel would depend only upon the initial velocity and the angle of elevation at which it was launched. Weight and volume are of no consequence.

With the same angle of departure and the same initial velocity the baseball and the football would travel the same horizontal distance in a vacuum.

In flight through air the latter acts as a resistance force to slow down the velocity of the projectile as it flies. Under equal conditions as to initial velocity, angle of departure, and weight, the effect of the force of air resistance will be greater upon a projectile whose cross-sectional area is greater. If the cross-sectional areas are equal, the heavier projectile will be less retarded than a lighter one.

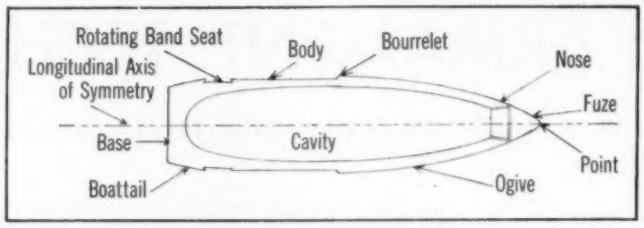


Fig. 1. Details of a modern spin-stabilized, high-explosive projectile.

In air the trajectory is not a true parabola. On the descending branch, the air resistance acts to slow up the horizontal component of the velocity to a greater degree than on the ascending branch. The descending branch is, as a result, steeper. A 15-pound projectile launched in a vacuum with an initial velocity of 1,250 feet per second and an angle of departure of 45 degrees would travel a horizontal range of about 16,100 yards. In air under the same conditions the projectile travels a horizontal range of about 9,600 yards.

Free To Rotate

The fin-stabilized projectile in flight is free to rotate around its long axis. If a projectile is eccentric and loaded into the mortar heavy side down there will be little tendency for the projectile to rotate around its long axis. However, if the projectile is loaded heavy side up or to either side, it will tend to start the projectile rotating around its long axis during flight.

In Figure 4, *M* represents a mortar projectile fired in still air at an angle of elevation *ROR'*. *A, B, C, D* represent points on the trajectory near the mortar. Arrows through these points represent the positions of the long axis of the projectile and crosshatch lines the direction of the onrushing air.

Axis Oscillates

As the projectile leaves the muzzle of the mortar its long axis is oscillating due to the turbulence of the powder gases. The amplitude of these oscillations decreases rapidly due to the action of the fins. In the horizontal plane, these oscillations soon disappear. In the vertical plane, as the amplitude of these oscillations decreases and gravity draws the projectile away from the line of fire, as illustrated at *B* in Figure 4, the projectile begins to fly with a yaw in the vertical plane.

Pressure on the lower side of the fins then starts the long axis to turn point downward. The yaw diminishes, and the projectile moves point on directly into the air. This downward movement of the point does not stop the instant the yaw is zero but continues beyond this point as illustrated at *C* in Figure 4.

Increased pressure now on the upper side of the fins starts the long axis turning in the opposite direction and the point moves upward. The projectile continues on its course, the point moving alternately above and below the trajectory.

If the fin-stabilized projectile having two sets of fins is rotating around its long axis, the fin area exposed to pressure in the vertical direction is constantly varying. This will cause variations in the amplitude of the oscillations of the long axis during flight. However, by using three or four sets of fins the effect of this rotation is greatly reduced.

This article has timely significance in view of the current artillery ammunition production program. Here are presented the basic causes which influence projectile behavior in flight. As analyzed by Colonel Wagner the importance of shell wall thickness is obvious—so also are other engineering characteristics of projectile design and production.

Colonel Wagner, now retired, was chief of the Artillery Ammunition Branch, Office, Chief of Ordnance. He has had long experience as an engineer in ammunition production and as an educator at the Ordnance School at Aberdeen Proving Ground.—THE EDITORS.

The flight of the fin-stabilized projectile is materially affected by a cross wind. In still air the projectile flies very nearly in the vertical plane of fire through the mortar. The resultant of the air-resistance forces lies in that plane.

Effect of Cross Wind

If during flight a cross wind blows from the right, the resultant resistance force changes its direction to the left and draws the projectile out of the vertical plane to the left. The projectile drifts to the left whereas the long axis points to the right in the direction of the resistance force.

In Figure 5, *P* represents the center of gravity of the projectile, *VV'* the trace of the vertical plane of fire, *PR* the direction and magnitude of the resultant of the resistance forces in the vertical plane, *WP* the magnitude and direction of the cross-wind force, *PR'* the magnitude and direction of the resultant of these two forces.

CP represents the direction of the long axis of the projectile after the wind starts to blow, *PP'P''* the path of the projectile, *P'B* and *P''E* positions and direction of the long axis of the projectile as it travels on its new course due to the cross wind.

The projectile flies with a yaw with reference to the trajectory but not with reference to the direction of the onrushing air. A cross wind from the right will cause the projectile to fall short and to the left of a target. In firing, correction must be made not only by moving the muzzle of the mortar to the right but also by elevating it.

Cross winds have greater effect on the fin-stabilized projectiles than on those stabilized by spin.

Nutations

The axis of the spin-stabilized projectiles in flight is subject to spasmodic small conical vibrations, called nutations, which are not to be confused with yaw or precession. The instant the spinning projectile leaves the gun the turbulence produced by the release of the powder gases causes nutations to occur.

The amplitude of these nutations is usually small, and, in the case of the concentric fast-spinning projectile, they disappear due to the action of equal and opposite centrifugal forces. If the spin were insufficient, the amplitude of these nutations would increase, soon causing the projectile to tumble.

The popular conception is that the spin-stabilized projectile flies like the fin-stabilized projectile. This is entirely erroneous. If this were true, modern projectiles fired at angles of elevation between 40 and 80 degrees would rarely, if ever, strike the ground point first. From many firings we know this is not the case.

In the fin-stabilized projectile the center of pressure is in rear of the center of gravity. That is, the resultant of all the forces of resistance acts to the rear of the center of gravity.

Center of Pressure

The center of pressure in the modern spin-stabilized projectile is forward of the center of gravity. In order, then, for the spin-stabilized projectile to fly the same as the fin-stabilized projectile, reacting to the forces in the same way, it would be necessary for the spin-stabilized projectile to turn over and fly base first.

The turning of the long axis of the spin-stabilized projectile in flight is in reality the precession of this axis. If a homogeneous symmetrical body is rapidly spinning around its axis of symmetry and a force is applied to turn this axis, the latter, instead of moving in the direction of the applied force, will turn off at an angle in the direction of the spin. The axis will move in a conical surface. This motion is called precession.

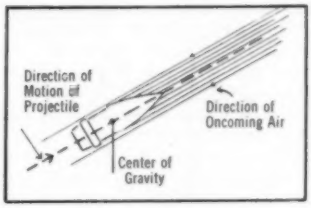


Fig. 2. Projectile in stable flight.

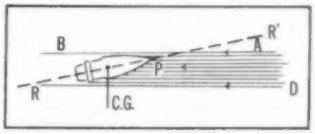


Fig. 3. Projectile flying with yaw.

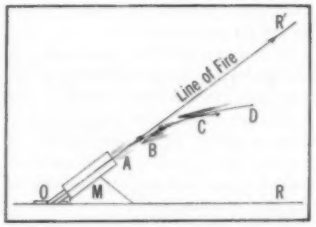


Fig. 4. Mortar projectile in flight.

The Spinning Top

The spinning top is the common example used to illustrate precession by applying the elementary principles of physics learned in high school.

Consider the symmetrical, homogeneous top spinning rapidly with its axis of spin in the vertical position (Fig. 6).

The only forces acting upon the axis are gravity, horizontal centrifugal forces, and horizontal tangential forces. The axis of the spinning top is temporarily in equilibrium because the centrifugal forces lie in horizontal planes and in any horizontal cross section of the top they are equal and opposite. Similarly, the tangential forces are equal, and their moment arms are equal. And, finally, the action line of gravity coincides with the axis of the top.

Result of Friction

The friction at the point and to a lesser degree the friction of the air slow up the spin. The slowing up disturbs the equilibrium of the forces acting upon the axis. The axis starts to tilt from the vertical, at which time gravity acts and the axis starts to precess.

Suppose *ADBC* to be a rigid T setting in the vertical plane *Z'O'X'* (Fig. 7) anchored rigidly at *A* and acted upon by the couple *DM* and *CH*. The distance *DB* and *BC* are equal. The only effect of the couple is to rotate *DC* around *AB*. Now suppose the original T is rotated in the vertical plane *Z'O'X'* through the angle *BAF*. Dotted lines indicate new positions. The direction and magnitude of the couple have not changed.

Whereas in its original position the couple had no tendency to move the line *BA*, in its new position *AF* this couple tends to rotate the line *AF* about its original position *BA*. The moment arm of the force *DM* with respect to the point *A* has decreased while that

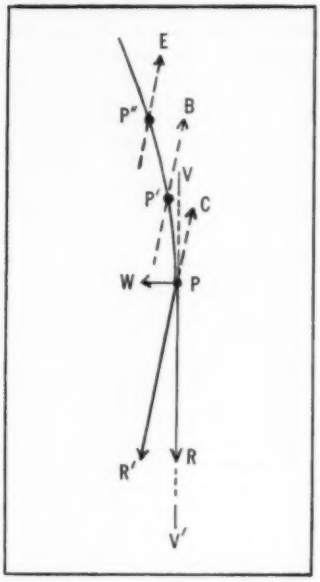


Fig. 5. Effect of cross wind on flight.

of *CH* has increased. The point *F* would therefore move in the direction of *CH* if equilibrium were disturbed.

Since the top is assumed to be homogeneous and symmetrical it will behave while spinning like one constructed as in Figure 8 where the mass is considered to be concentrated in four equal spheres *A, E, D,* and *B,* fastened to the end of the rigid rods *EB* and *DA* which are attached to the axis rod *RP*.

When spinning rapidly with its axis rod vertical (View Q, Fig. 8), the latter is in equilibrium. If, however, the top is set to spin left to right with its axis inclined at an angle to the vertical (View N, Fig. 8) gravity acts to turn the axis downward. The small spheres are now moving in an oblique plane.

Centrifugal Forces

As was the case when the axis was vertical and the spheres moved in the horizontal plane, the centrifugal forces are equal and opposite and have no tendency to move the axis. Tangential forces are also equal but their moment arms have changed.

In spinning, as the spheres pass through the points *D'* and *A'* (View M, Fig. 8) the tangential forces are equal and their moment arms with respect to the original position of the axis *P'V* (View N, Fig. 8) are equal and have no tendency to move the axis *C'P* around this line.

However, when the spheres in rotating approach the points *B'* and *F'* the moment arms of the tangential forces are unequal, those to the right of the vertical line *P'V* being greater than those to the left.

Cone Generated

At *E'* and *B'* we have a condition analogous to that illustrated in Figure 7. The point *C'* moves off in the direction of the tangential force at *B'*. The tangential force at *B'* lies in a horizontal plane so that the point *C'* will be constrained to move in a horizontal circle with radius *UC'*. The axis *R'P'* generates a cone as it moves. Gravity acts to pull the axis *R'P'* further away from the vertical line *P'V* which is the line of no precession.

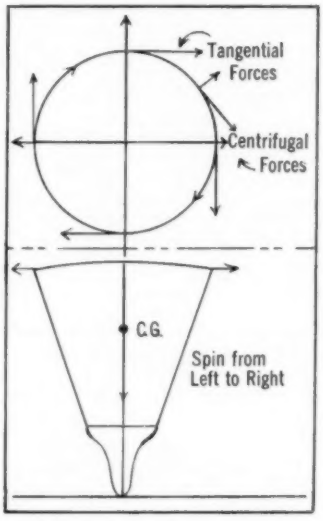


Fig. 6. Forces acting on spinning top.

In so doing, however, it is tending to change further the moment arms of the tangential forces which produce the conical motion of the axis and thus keep it going. Therefore, instead of causing the top to fall, the force of gravity keeps it precessing as long as the spin is maintained.

As the velocity of spin falls off, the forces causing precession diminish, and precession tends to slow up. However, as this begins to happen the forces of gravity cause the axis to move downward farther away from the vertical line *P'V*.

The change in the moment arms of the tangential forces offsets the diminishing spin, and the precession becomes faster than it was before the spin started to diminish.

The precession of the common spinning gyroscope more nearly simulates that of the flying spin-stabilized projectile than does the spinning top. In the latter, gravity is the overturning force. When the axis of the spinning top is vertical there is no overturning moment and no precession.

If the axis of the top is displaced angularly, gravity acts to draw the axis farther away from the vertical, and precession begins.

Angular Displacement

In the case of the spinning gyroscope, the center of gravity is at the center of rotation. Angular displacement of the axis takes place around this point. If there were no friction and no outside forces acting, the axis of the spinning gyroscope would remain pointing in exactly the same direction at which it was set.

If an overturning force acts to displace the axis angularly, the axis moves an almost imperceptible distance in the direction of the force. This is sufficient to disturb the equality of the moment arms of the tangential forces, and then the axis moves off laterally from the direction of the force but in the direction of spin, and precession begins.

The axis in precession generates a cone whose apex is at the center of gravity of the gyroscope. The apex angle of this cone will be equal to twice the angle between the direction of the force and the axis of the spinning gyro-

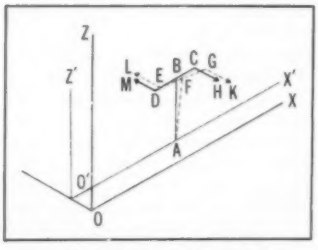


Fig. 7. Effect of change in equilibrium.

scope before it begins to precess. As this angle approaches ninety degrees, the axis will precess in a plane. Any change in the direction of the force with respect to the original direction of the axis will cause the apex angle of the cone to change.

Initial Rotation

Assume the gyro wheel (Fig. 9) is spinning around the horizontal axis *A* in the direction indicated by the arrow; *i. e.*, from left to right. If a small weight is hung on the gyroscope frame at *A* there will be an initial slight rotation of the axis *A* about the horizontal axis *B*. This changes the moment arms of the tangential forces acting in the gyro wheel. As in the top, the axis *A* will start to rotate in a clockwise direction, pivoting around the vertical axis *C*.

If instead of hanging the weight at *A* it were placed at *D*, the axis *A* will pivot around the axis *C* in a counter-clockwise direction.

If the spin is constant, the rate of precession increases or decreases as the moment of the weight increases or decreases. The moment of the weight is equal to the product of the weight times its distance to the center of gravity of the gyro wheel. It varies if either the weight or the distance varies. It is called the overturning moment. If the overturning moment is constant, the rate of precession varies inversely as to spin.

Line of No Precession

The foregoing discussion assumes that gravity is the overturning force and, hence, does not change its direction. In this case the vertical line is the line of no precession. If the axis of the spinning gyroscope is displaced from the vertical by the action of a small weight, the axis will precess to generate a cone. As long as the spin is constant, the apex angle of the cone which is generated by the axis will remain substantially the same.

If the direction of the overturning force changes, the apex angle of the cone generated by the axis in precession will also change.

In Figure 10, suppose *EF* represents the vertical line of no precession. If the axis of the spinning gyroscope is displaced from the vertical through the angle *EOA* and Force 1 (parallel to *EF*) acts, the axis will precess, generating a cone whose apex angle is *AOB*.

Now suppose that just as precession starts Force 1 changes its direction to 2. The axis will start to generate a cone whose apex angle is *AOC*. If the direction of force changes to 3 the apex angle will become 180 degrees or a plane surface.

In other words, as the direction of the force changes, increasing the angle which it makes with the line of no precession, the apex angle of the cone generated by the axis in precessing increases until it reaches 180 degrees after which it begins to decrease.

If the axis is precessing faster than the direction of the force is changing, the axis moves a short distance in the smaller cone before it starts to move in a larger one.

The conical surface generated will, therefore, begin with a small radius of curvature which will gradually increase until the surface becomes a plane. After this the curvature will change to the opposite side and the radius of curvature will begin to decrease.

Line of Fire

The straight line through the center of the bore of the gun is the line of fire and also the line of no precession. As the projectile leaves the gun it is spinning rapidly, the center of pressure is at or very near the point, and the direction of the resistance forces is parallel to the line of no precession (*A*, Fig. 11). There is no precession. The projectile is flying without yaw.

As gravity draws the flying projectile away from the line of fire (*B*, Fig. 11) onto its curved trajectory, the direction of the resistance forces slowly begins to change. This change takes place only with respect to the horizontal. The center of pressure moves slowly from the point toward the base along the ground side of the flying projectile. The projectile begins to fly with yaw.

The change in direction of the resistance forces away from the line of fire causes precession of the long axis to begin. With right-hand spin the point of the projectile begins to turn downward and to the right.

Slow Change

On the ascending branch of the trajectory the resistance forces change direction relatively slowly. Precession proceeds faster than the direction of the forces changes. The axis of the projectile behaves similarly to the axis of the gyroscope.

As precession starts, the conical surface generated by the axis in precessing has a small radius of curvature so that the movements of the point to the right and downward are about equal.

As the projectile approaches the summit of the trajectory, the resultant of the resistance forces changes its direction more rapidly than the axis is precessing so that the radius of curvature of the conical surface generated by the axis increases more rapidly. The point of the projectile starts to move downward faster than it does to the right.

When the projectile passes over the summit of the trajectory and starts to travel on the descending branch, the change of direction of the resistance

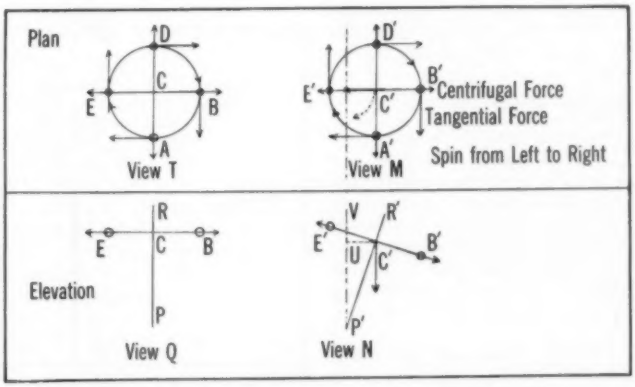


Fig. 8. Plan and elevation aspects of forces acting on top to cause precession.

force is further accelerated, keeping pace with the rate of precession. The radius of curvature of the conical surface generated by the precessing axis increases rapidly.

Becomes Plane Surface

In high-angle fire (about 45 degrees gun elevation) it becomes infinite, then changes its direction 180 degrees and begins to decrease. In other words, the conical surface becomes a plane surface after which the direction of curvature changes from concave to the left and downward to concave to the right and upward.

The point of the projectile falls rapidly. The turning to the right is arrested for an instant after which it is resumed at an increasing rate, while the rate of turning of the point downward is slowed up. This change in the direction of curvature of the conical surface generated by the precessing axis is largely responsible for the relatively greater drifts observed in high-angle fire as compared with those observed at low angles. Contributing factors are the speeding up of the precession due to the falling off of the spin and the slowing up of the change in direction of the resistance force.

If, when fired at high angles of elevation, the spin is too great, the rate of change of the direction of the resistance force proceeds so much faster than the axis precesses that the projectile gets well under way on the descending branch of the trajectory traveling base first. The center of pressure of the resisting force moves past the center of gravity to the rear. The direction of precession changes from right to left, to left to right. The projectile strikes the ground base first or lands on its side.

"Magnus Force"

When the projectile is flying with yaw there is another force which acts to produce deviations in flight. The magnitude of this force increases as the yaw increases. This force is known as the "magnus force." The magnus force is the force which causes a golf ball when hit with a slice to go off to the right or, when hooked, to go off to the left.

In Figure 12 the circle *ABC* represents the view looking down from above of a flying golf ball which has been hooked and is spinning counterclockwise.

Due to the spin, the quarter surface of the ball included between the vertical planes through *OB* and *OA* will be traveling into the air with greater speed than any of the other three quarters of the ball's surface. The resistance on this quarter will be greater, resulting in greater pressure. This pressure will cause the center of gravity of the ball to move left in the direction *OD*.

In the case of the spinning projectile flying with yaw, the magnus force will develop on the right-hand side, tending to move the center of gravity of the projectile to the left. In high-angle fire its effect will be greatest near the summit of the trajectory when the yaw is greatest. It acts to reduce the over-all drift to the right.

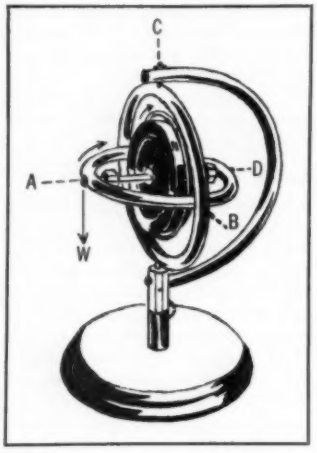


Fig. 9. Gyroscope demonstrates precession.

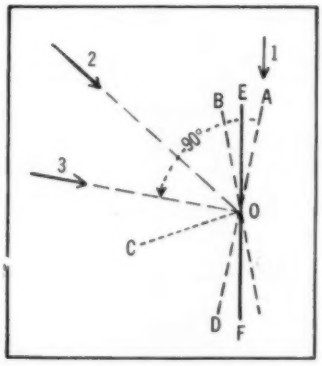


Fig. 10. Forces acting on the gyroscope.

In the foregoing it is to be noted that the resultant of all the resistance forces acts at a moving center of pressure. As the projectile starts its flight, the center of pressure is at the point. During travel the center of pressure moves toward the base along the underside. After the projectile noses over in flight, falling point first, the center of pressure starts to move toward the point. In modern projectiles, except when falling base first, the center of pressure is forward of the center of gravity.

Effect of Eccentricity

It has been assumed that the projectile is symmetrical and concentric and is spinning around its long axis of symmetry passing through the center of gravity. If the projectile is eccentric due to variations in wall thickness, the axis of rotation is not the axis of symmetry of the external surface.

While in the gun, however, the eccentric projectile is spinning around that axis, and the axis is parallel to the bore of the gun. The center of gravity is actually rotating around the axis. When this happens, balloting is apt to occur in the bore of the gun, and the characteristic rifling marks appear on the bourrelet.

After the projectile leaves the bore the action of centrifugal forces changes the axis of spin from the axis of symmetry of the external surfaces to the longitudinal axis of gravity. The former axis of spin starts to rotate around the new axis of spin. The projectile will hop laterally with respect to the gun a short distance.

The longitudinal axis of gravity is a mean axis. In addition to the forces causing precession, there are unbalanced centrifugal forces which are acting to set up nutations in the axis which continue as the axis precesses.

Range Variations

During the era of the hollow cannon ball, efforts were made to increase the range by firing eccentric balls. When a ball was loaded into the gun heavy side up and fired, it was found that it traveled farther than a similar concentric ball fired under like conditions. When a ball was loaded heavy side down and fired it fell short of the concentric ball. The concentric ball did

not spin. In the gun the powder pressure caused the light side of the eccentric ball to move faster than the heavy side so that both eccentric balls spun.

If the concentric ball could have been made to spin, different ranges would have been obtained with two identical concentric balls fired at same muzzle velocities and gun elevations but with opposite and equal spin. In Figure 12, if *ABC* is taken to represent the ball viewed from the right hand side and spinning counterclockwise, the magnus forces will tend to raise the ball as it travels and increase the range over that of the nonspinning ball. If the spin were clockwise the range would be less.

Varying Force

When the ball is eccentric the magnus force is greater. The ball is rotating around its center of gravity, which is not the center of symmetry of the external surface. The area of fastest travel and greatest pressure (Fig. 12) is alternately greater and less than was the case with the otherwise similar concentric ball. A varying force is developed to move the center of gravity upward.

In the case of the eccentric spin-stabilized projectile, the variable magnus force will cause greater lateral deviations depending upon the amount of eccentricity.

When the projectile is spinning around an axis other than the axis of symmetry of the external surface it offers a greater area of resistance to the air. The retardation is greater and the expected range less.

In Figure 13 a projectile flying with yaw and spinning about *RR'* with center of gravity at *C*, moves to *C'* and the projectile makes a half turn about axis *RR'*. The major axis of the ellipse of cross-sectional area exposed to air resistance increases from *AB* to *DE*. If in addition there were nutations in the axis *RR'* the difference in areas would be further increased.

Effects Summarized

Summing up the effects of eccentricity upon the flight of the spin-stabilized projectile:

1. It increases the rate of retardation of the linear velocity due to the fact that a large cross-sectional area is presented to the air.

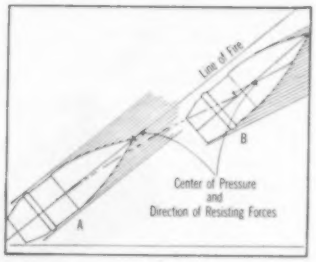


Fig. 11. Effect of resistance forces.

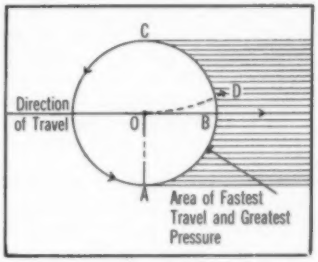


Fig. 12. Example of golf ball in flight.

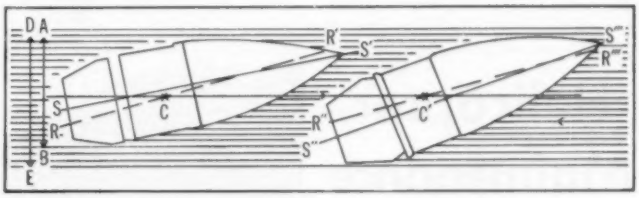


Fig. 13. Effect of eccentricity on spin-stabilized projectile.

2. It accelerates the rate of precession. The spin is retarded more rapidly, because the axis of spin is not the axis of symmetry.

3. The magnus force is greater.

As is to be expected, the longitudinal and lateral deviations of the projectile in flight due to eccentricity are much more pronounced at the longer ranges. If the time of flight is sufficiently long, the amplitude of the nutations will increase to a point where the projectile starts to tumble. This will be caused by the low spin and fast precession.

Prodigious Task

It is evident that to attempt to assess these deviations quantitatively would be a prodigious, if not impossible, task. The present prescribed limits of variations of wall thickness now allowed by specifications have been tested by years of experience.

Just what would be the change in the present allowable probable error in range and deflection of a particular type of projectile by permitting an additional hundredth of an inch variation in wall thickness cannot be stated.

The probable errors of artillery projectiles, particularly at the long ranges, are now considered too large by artillerymen. Nothing should be permitted to increase them. From a machining standpoint the prescribed limits on variations of wall thickness are quite generous, and with modern machines and careful workmanship they can easily be maintained.

Writing on "Progress in Ammunition" in the November-December 1950 issue of ORDNANCE, Donald R. Beeman, assistant chief of design and engineering development at Picatinny Arsenal, Dover, N. J., said:

"The advent of the atomic bomb and the widespread speculation as to 'push-button' warfare may easily lead one to suppose that conventional ammunition of all types has been relegated to a secondary or inferior position in the scheme of modern warfare. This is far from the truth. Push-button warfare is not yet a reality, and even if this type of warfare does become possible there will still be heavy requirements for all types of conventional ammunition for a wide variety of operations, including both amphibious and airborne landings and other operations connected with occupying and holding strategic positions.

"It is obvious, therefore, that any future conflict must include plans for the use of conventional types of ammunition, improved and perfected for maximum effectiveness."

Using tandem rotors, the H-21 is the "work horse" of the cargo helicopters.

Helicopter Maintenance

"If we are to have an important helicopter program in the Army, it is obviously essential that we develop a maintenance system which will support that program and which will be as economical as possible."

By

Col. William B. Bunker

Chief, Air Transport Service Division, Army Transportation Corps

THOSE of us on the operating side of the Army's helicopter program have been vigorously fostering plans for the large-scale use of this important new vehicle. However, maintenance people generally and even some of our own staff seem to feel that the mechanical support of a large helicopter program would prove very difficult and expensive, if not impossible. They point to the three mechanics considered to be the minimum for the successful support of the small utility helicopter we are now employing and question our ability to support any great number of larger machines.

Our helicopters to date, they remind me, have caused us maintenance problems which have often seemed out of all reasonable proportion to the useful work they have performed.

If we are to have an important helicopter program in the Army, it is obviously essential that we develop a maintenance system which will support that program and which at the same time will be as economical as possible. It seems that now, while we are at the threshold of this program, is the proper time to examine and discuss its impacts.

The full exploitation of the advantages of the helicopter will require many changes in our tactical and logistical concepts as well as in maintenance practices, but by anticipating them we should be able to minimize difficulties which these changes cause.

Appreciation Delayed

Full appreciation of new developments in logistics has usually been delayed by the reluctance of the Army to make the required modifications to its doctrine and procedures. Mechanical development in the helicopter field is proceeding rapidly; we must show a parallel industry in modifying our concepts to capitalize on it.

Let us first examine the vehicle itself. The cargo helicopters presently being manufactured for Army organizations consist of two types: the single-rotor, 8-passenger H-19 (Sikorsky) and the tandem-rotor, 18-passenger H-21 (Piasecki).

Similar in Design

Both are powered by standard aircraft engines, driving through spiral bevel reduction gears with power take-off. The fuselages are of more or less standard aircraft monocoque construction, and both are controlled through a series of levers and cables which change the pitch of the rotor blades.

In all helicopters the engines are operated at a fairly high rate of speed because of the requirement for maintaining a relatively constant rotor speed. This usually results in more maintenance difficulties than are experienced with the same engine in conventional aircraft.

While both of these machines are quite new, they are actually modifications and improvements of designs which have been in operation for some years. Other designs which will be in production for the next several years are all similar to one of these two basic types with larger engines and other components. Radical departures such

as tip-mounted jets, gas turbines, and such are still in the development stage.

Helicopter maintenance problems arise from the requirement to develop larger and more complicated control and power-transmission devices coupled with the necessity for keeping the empty weight of the machine as low as possible. Since the helicopter is in a rapidly growing stage of its development, frequent changes and modifications of design are necessary, and new mechanical difficulties are always emerging.

Frequent Inspection

The primary maintenance workload of the helicopter arises from the necessity for frequent inspection of assemblies and components. The helicopter here follows standard aircraft practice which requires that assemblies such as engines and gear trains be torn down and examined periodically to insure their continued safe operation.

The interval of this inspection is established by experience, and hence these components require more frequent inspection in their early stages than after they have been in service for some time.

The small utility helicopter which has performed so well in Korea has been successful from the maintenance point of view largely because it has been obsolete for four years, and hence the service life of its components and its critical features are well understood.

Our newer machines have had only limited operation, and hence the inspection periods for the major components are still quite short. Also since new mechanical developments are certain to contain weak points and "bugs" which can only be discovered after extended periods of actual operation, our maintenance problems are aggravated.

Spare-parts supply is likewise based on experience, and lack of experience is reflected immediately in poor spare-parts supply. Cargo helicopters have not yet been available to the Army in quantity—in fact the total production of these machines to date is only about one hundred. As a result, the spare-parts problem is complicated by small volume and wide dispersion.

During Operation Snowfall we spent four weeks trying to get one small shaft worth about $20 from Texas to the maneuver since there was no nearer source of supply. When there are more machines in use and the flow of spare parts has been established, it is hoped that this situation will be improved.

Spare Parts Problem

Spare-parts supply will, however, remain a large problem in any helicopter program. Commercial operators of helicopters and manufacturers are generally agreed that at the present status of design the helicopter consumes approximately one per cent of its value in spare parts per month.

In the development of the small utility helicopters now in general use by the Army, the manufacturers gave far too little attention to their maintenance aspects. As a result, much loss of motion is entailed in all routine operations, components are inaccessible, assemblies interconnected, alignment very difficult, and generally they are a mechanic's nightmare.

Long Operation

As an illustration, the engine change in a small, 2-place utility helicopter takes five times as long as the similar operation on a tank. However, widespread criticism of the maintenance problems with these machines has led the manufacturers to recognize the value of ease of maintenance in their new designs.

The cargo helicopters now under production and the new types being developed are designed so that major components such as rotor systems, engines, transmissions, etc., are easily accessible and can be exchanged in a minimum of time. Difficulties of rotor alignment and the delicate balance of rotating parts are being moderated, and it can be expected that as these machines go into mass production they will be as easy to maintain as it is possible to make them.

One other characteristic of the helicopter which should be kept in mind in examining the maintenance problem is its cost. Present helicopters cost about $250,000 to $300,000 per thousand pounds of lift. While these figures will be reduced somewhat by mass production, it is not felt that they will become comparable to trucks or river craft in the foreseeable future.

Components Inexpensive

On the other hand, the components of the machine which are subject to wear are relatively inexpensive individually. Transmissions cost only eight hundred to a thousand dollars, rotor heads somewhat less, and blades a little more.

Obviously a considerable economic advantage will accrue by getting the maximum use of the aircraft as a whole with exchange of faulty or worn components.

Before examining the maintenance organization in detail we should also establish our expected employment of these aircraft. The memorandum of agreement between the Secretaries of the Army and the Air Force estab-

The H-19, below, is the only type of cargo helicopter now being used in Korea.

lished that the Army's helicopter units would be used as organic Army transportation to supply their services to the Army commander in the combat zone.

Helicopter Control

As such it is contemplated that the helicopter companies and battalions will be employed by placing them for more or less limited periods of time under operational control of a division, regimental, or even battalion commander to perform specific tactical and logistical missions. This employment contemplates substituting helicopter transportation for Army truck movement when the absence of roads, bridges, and other facilities, or snow, mud, and similar weather conditions make ground supply impracticable.

Under this concept the requirement for a particular helicopter unit will usually be sporadic and of more or less limited duration. It is felt that the helicopter will reinstate battlefield maneuver into our inventory of resources and will find its greatest tactical employment in river crossings and envelopments.

Helicopter battalions will be of great value in the movement of reserves and the positioning of units in areas otherwise accessible only by laborious forced marches. Logistically, the helicopter will be used to replace temporarily interrupted lines of communication and to compensate for disruption of normal supply by the loss of supply installations and other factors.

The concepts of employment outlined above demand an organization which is flexible and mobile and which can exert its maximum effort with little time for planning and special instructions.

Supply Always Limited

The cost of the helicopter is such that it will probably always be in limited supply. Already requirements for its service far exceed its availability. It is essential in establishing doctrine and organizations for the employment of these machines that they be compatible with such usage.

From the foregoing, the requirements of a satisfactory helicopter maintenance system can be formulated. Obviously the first requirement is that the maintenance system facilitate the accomplishment of the helicopter's basic mission and interfere as little as possible with the concept of employment.

For this reason the maintenance system must be designed to insure the maximum availability of assigned helicopters at all times. It should utilize the nonflying periods, particularly nighttime, to the maximum. It should be capable of supporting detached operations away from home base for more or less extended periods, and it must be instantly capable of maximum effort with little time for planning.

From the maintenance factors built into the machine, the system should make the greatest possible use of assembly replacement and exchange procedures. Every effort must be made to keep the basic vehicle operable as long as possible. Maintenance requirements will be primarily for inspection of component assemblies on the service-life basis.

Further, it is obvious that the maintenance system will involve a major supply operation covering a very wide category of items.

Company Organization

As presently organized, the Transportation Helicopter Company consists of twenty-one cargo helicopters with a maintenance section of one officer, one warrant officer, and forty-six enlisted helicopter mechanics.

In keeping with the Army system of maintenance, these mechanics are only responsible for organizational maintenance, which actually covers little more than adjustments to the aircraft.

Inspection Requirements

Other than preflight and postflight inspections, maintenance checks on the helicopter normally require the removal of accessories and components which automatically classifies these operations as field maintenance.

The present concept contemplates the maintenance of cargo helicopters by Light Aviation Maintenance Companies organic to the corps or field army. These companies are composite, designed for the repair of light fixed- and rotary-wing aircraft organic to divisional units. The teardown, inspection, and rebuild of assemblies is presently scheduled as depot maintenance for Ordnance companies in the rear areas.

This system is not compatible with the requirements as established above, and it seems apparent to me that a separate maintenance system for large cargo helicopters should be established rather than trying to warp helicopter problems into a pattern established primarily for motor vehicles.

In view of the limited amount of actual organizational maintenance pos-

Equipped with both skids and wheels, the H-13 utility helicopter, above, is rapidly becoming indispensable to the troops now active in Korea.

sible on a helicopter, it is proposed that maintenance personnel be eliminated from the Transportation Helicopter Company. In lieu of mechanics, there should be one crew chief per aircraft permanently assigned by vehicle. This man should be responsible for servicing and visual checks of the aircraft.

Crew Chief's Duties

The crew chief would accompany the helicopter to the maintenance organization and assist the mechanics in inspections and maintenance. This crew chief, in addition to his maintenance functions, would accompany the aircraft on its missions and assist in ground handling, loading and unloading cargo and personnel, and related activities.

The primary purpose of this proposal is to make the helicopter company an operating organization. As matters now stand, the company commander is usually more concerned with maintenance and its related problems, and little time is available to him for actual management of his operations.

In order to accomplish helicopter maintenance efficiently and economically and to secure a high degree of availability it is proposed that helicopter units be organized into battalions of three operating Transportation Helicopter Companies and one Ordnance Supply and Maintenance Company.

This Supply and Maintenance Company would be responsible for a combination of organizational and field maintenance on cargo helicopters and would be manned and equipped specifically for this function. The maintenance platoon of this company would be organized with six teams of eight inspectors each of which would perform all the scheduled intermediate inspections on the aircraft in the operating company area. If a company is detached for more than twenty-four hours to an area removed from the battalion base, two of these teams would accompany it.

A Shop Section

Additionally, there would be a shop section to operate the battalion maintenance shop on a production-line basis for all major maintenance inspections at a base rate of three or four machines a day.

The primary method of operation of the battalion shop would be to exchange assembly components of the cargo helicopter as dictated by the service life or mechanical difficulty. It would also perform such emergency repairs to the helicopters as was necessary.

This company should be organized under the concept of keeping the helicopter itself operable as near one hundred per cent of the time as possible by performing its work during the normal nonflying periods of the companies.

As the helicopters of the operating companies become due for inspection the inspection teams will perform their checks in the company areas, drawing such replacement parts as are necessary from the supply platoon. If more extensive work is indicated or a major inspection is required, the machine will be taken to the battalion shop where the requisite tools, facilities, and equipment are available. By replacing the major assemblies as required, it should be possible to return the helicopter to the operating company in a few hours even from a major inspection.

Stock Spare Parts

The other principal function of this company is to stock the spare parts required for the operation of the helicopter battalion. Based on our limited experience to date it is estimated that the helicopter battalion would require almost 250 tons of supplies and tools and would use spare parts at the rate of about $250,000 a month.

This is a supply problem which in the interest of efficiency and economy should be handled by a supply organization directly connected into the proper procurement and distribution channels.

The Ordnance and Supply Maintenance Company will be supported by a Helicopter Assembly Rebuild Company. This company, located in rear areas where proper production control facilities can be established, is responsible for servicing major components received from the maintenance company on an exchange basis. As the maintenance company removes an assembly from the helicopter it will exchange it with the Assembly Rebuild Company for a serviceable one.

By using this system it should seldom be necessary to send the helicopter itself to the rear, and the most economical use can be made of our capital investment.

Progressive Inspection

Coupled with this organization for streamlining organizational maintenance we should also adopt a maintenance pattern which will insure the highest possible utilization of our machines. Commercial operators of both fixed- and rotary-wing aircraft have quite widely adopted the system of progressive inspection. This system involves the division of the periodic inspection into segments which can be performed in the intervals between scheduled operations.

While it is true that performing these operations in this manner requires some increase in the total number of man-hours, this is more than offset by continued availability of the aircraft.

At present, helicopter operations are limited by pilot characteristics and operating difficulties to about four hours a day. Developments in instrumentation and automatic pilots should enable us to increase this to six hours a day, considered standard by the Air Force for fixed-wing transports.

Assuming an equal time for loading, servicing, and similar functions, this would leave twelve hours a day in which the helicopter would be available for maintenance operations. By using the maintenance system and organization here proposed, it should easily be possible to maintain ninety or ninety-five per cent of the helicopters in a battalion operable each day.

Full-Time Support

The helicopter is an instrument of opportunity, and its maintenance must be geared to full-time support at all times. For these reasons I have proposed here a tailor-made maintenance system for this vehicle which will insure its most efficient employment and economical maintenance.

(NOTE.—The foregoing article represents ideas of the author and not necessarily those of the Ordnance or Transportation Corps or the Department of the Army. They are presented here to encourage thought and discussion of one of the major maintenance problems of tomorrow's Army.)

Building Dependable Ordnance

A Complex Device Is Only As Good As the Sum of Its Parts

By

Vernon M. Korty

Chief, Fuze and Signals Branch, Technical Evaluation Division, Naval Ordnance Laboratory, White Oak, Md.

"The guided missile contains hundreds of component parts, each of which must function exactly as intended or else result in failure of the whole weapon—a sort of modern heel of Achilles"

HISTORY indicates that our Nation has often relied on mechanical devices rather than large standing armies of men to be ready for instant action in the event of armed attack. In war we have often overcome deficiencies in manpower by use of such means.

During World War II these ordnance devices were apparently quite effective. "We were able to use machines and technology to save lives," said Gen. Dwight D. Eisenhower.

Death Toll Reduced

And Gen. J. Lawton Collins has stated that "the logistical superiority in mobility and firepower provided by our science-industry-military team kept our battle-death toll down to only twenty per cent of that of the enemy's, even though we conducted operations all over the world—often with strategic inferiority in numbers of troops."

With the advance of science and the spreading of conflict over the globe, these "devices"—these weapons of war, together with all their component parts—have naturally become more and more complex. The modern guided missile, for example, contains hundreds of component parts, each of which must function exactly as intended or else result in failure of the whole weapon—a sort of modern heel of Achilles.

Questions Asked

How may these components be developed in order that acceptable reliability can be achieved? How can we be assured of their reliability? How and when can this reliability best be measured? These are questions we wish to examine more closely in this paper.

The life history of any successful piece of ordnance can usually be catalogued under the following phases: research, development, technical evaluation, production, service use, and surveillance.

These are terms used in the Navy, but similar ones are found in the other services and in industry. Of these, the research phase indicates the *possibilities* for development; the surveillance phase is a *postmortem* on service matériel which indicates how well it has stood up in storage after it has once been produced.

Hence, for our purposes in studying reliability of a "living" piece of ordnance, let us concentrate on the remaining four phases.

The development phase is concerned with the details of producing a satisfactory set of drawings and specifications from which a useful device can be manufactured. Hence it is necessary, during, and even before, this phase to have basic information on the conditions, favorable and unfavorable, which affect the device.

Environment Limited

It becomes necessary to circumscribe the environment in which the device will be expected to live—the limits of heat and cold, the shock patterns, vibration, moisture, corrosive atmosphere, background noise, and a multitude of other factors. It has become customary during design to utilize the maximum conditions indicated in such a preliminary study, plus a suitable "factor of safety," as the minimum acceptable values during development.

Choosing the proper factor of safety becomes a matter for serious study. Overdesign is expensive of materials and may make the device too heavy and bulky; underdesign may lead to failures due to metal fatigue or failures during the production phase when tolerances must be opened up in order to use unskilled workmen or mass-production techniques.

Proof Difficult

With the small number of samples available (each of which may be very expensive when handmade from engineering sketches) it is usually not possible to prove out, with any real statistical assurance, the reliability which has been so laboriously built in.

Engineering judgment and experience with other devices which have successfully passed through the later phases are perhaps the best available guides during this critical phase.

Pilot Production

In this phase the drawings, specifications, materials lists, and classification of defects are evaluated to determine whether or not it will be possible by their use to manufacture a reliable and useful product. With the plans fairly well frozen, it now becomes possible to produce a sizable number of devices in "pilot production" with production tooling, and statistical techniques may be used profitably during the testing program.

During this phase, which exists in the industry under various names, it is common to apply those test conditions

which the service item would be expected to sustain in what is believed (by engineering judgment) to be the most severe combinations, under the assumption that the device will pass the test satisfactorily.

Factorial Test Design

If and when it does *not* pass, then we try to find out why and to make improvements. When in doubt as to what are the important parameters, or what are the most serious combinations, a factorial test design can often be developed to ascertain this information from a portion of the sample available.

This test procedure, long used in the agricultural and biological sciences, is beginning to find many applications in ordnance testing.

In the testing of the design our objective is always to demonstrate that the device is reliable and effective over the whole range of expected environment, with a reasonable factor of safety—*i.e.*, with something to spare—and that this reliability can be reasonably expected to be maintained in the production phase. Some of the statistical methods which are applicable are treated briefly in a later paragraph of this paper.

Techniques Improved

Evaluation techniques have greatly improved in the last decade. It is now possible to measure in the laboratory and in field test stations the capabilities and deficiencies of any piece of ordnance, not by cookbook methods but by careful study of the device and application of intelligently chosen conditions of shock, temperature, etc.

It is customary at this time also to develop simple tests which can be used during the production phase to maintain the quality level of every component part.

Usually changes in drawings and specifications become necessary as a result of the findings in this phase. These are introduced and checked out before entering manufacture. In the Navy a "mark" number is usually assigned at this time.

In the production phase the device goes from pilot-lot to full-scale production. There is here many a new problem and consequent threat to the reliability of the device, owing to the expanded tolerances and techniques which must be adopted to mass-produce it.

Since in this phase we are dealing with large numbers of items, it is possible to use to good advantage the methods of quality control. These are especially useful for testing random samples of component parts to insure that the quality does not fall below acceptable limits.

Spot checks can be instituted to insure that the reliability of the whole assembled device does not fall below any chosen quality level, with a known set of risks to producer and customer. These methods have been widely publicized and need not be discussed here.

"In the testing of the design our objective is always to demonstrate that the device is reliable and effective over the whole range of expected environment, with a reasonable factor of safety . . . and that this reliability can be reasonably expected to be maintained in the production phase."

At long last the device gets into service use. This is the proof of the pudding—the ultimate purpose of all the work which has gone before. Rear Adm. J. A. Snackenberg, speaking before a group of Reserve officers in the Navy Bureau of Ordnance, expressed this very well when he said:

"If the bomb or if the ammunition does not explode, if there is a misfire in the gun, so far as they are concerned this Bureau has been wasting its time and money . . . Everything we provide is of a 'one-time' nature. It gets one chance. If it doesn't work, it is no good. If it does work, that is what they expect."

School of Experience

Here the device is finally evaluated for reliability in what has been called the "school of bitter experience." But here the test operator often loses control of the test variables, and data on causes of failures are often hard to obtain.

Of the four phases discussed above, it is the technical-evaluation phase (by whatever name it may be called) which offers the best opportunity to measure the reliability which may be obtained or expected, since a sizable number of samples is available at the same time that controlled conditions are available to the engineer.

The data obtained from these tests will be of two kinds: (1) Those in which something is measured numerically, as for example the pressure at which a diaphragm ruptures to close an electrical switch, or (as another example) the critical voltage to strike an arc in a gas-filled tube; and (2) those in which the result is simply that some effect is observed or it isn't observed, as for example that a bomb fuze does function or does not function when the bomb is dropped on an airstrip.

Handled Differently

Handling of the data taken in these two cases, in order to get a measure of reliability associated with the operation, is somewhat different.

Take Case 1, for example. Diaphragms for pressure-arming one type of rocket fuze are best tested by subjecting a number of samples to simulated rocket pressures (*i.e.*, presenting to the diaphragms the pressure-time curves which approximate field conditions) and then measuring the critical pressure for collapse for a number of samples.

One can measure the fifty per cent point and the standard deviation, estimate the distribution, and then estimate the percentage which would arm satisfactorily with the pressures which exist in the service round.

Reliability Estimated

By testing throughout the temperature range of the rocket, applying the appropriate pressure-time curves associated with each temperature, one can estimate similarly the arming reliability under these conditions.

The second case is more of a problem. In such "go, no-go" situations, it is possible to utilize "confidence limits" to express the result, but these are usually of little value when a high degree of confidence is desired.

Suppose a number of samples are tested at a set of maximum conditions which the device must endure. Twenty devices which all operate exactly as desired indicate that ninety-three to one hundred per cent of such devices should prove to be reliable from production. These are fifty per cent confidence limits; *i.e.*, in a long run of

such estimates you will be right more times than you are wrong when you say the probability of reliable operation lies within this range.

83 Per Cent Reliable

If you want to be right 19 times out of 20, then you can only say from these 20 samples that at least 83 per cent reliability can be expected when such devices are produced in large numbers without decrease in quality.

Raising the number of samples tested to 100 without experiencing a failure allows one to say with the same confidence (95 per cent) that the reliability is at least as good as 96 per cent. This is pretty unsatisfactory estimating, and one does not get the most information possible from each sample.

A better method for many situations is testing the device to failure and measuring the point where it finally fails. When testing explosive trains, for example, one can introduce gaps which are larger than those which can ever occur in the production assembly until train failures are obtained.

Testing around this condition and extrapolating back to expected service assembly conditions provide numerical estimates of the reliability which are far more efficient than the crude bracketing by confidence limits.

Statistical Plan

One could increase or decrease the thickness of metal in mechanism housings, in accordance with a statistical plan, until one reaches the point of failure or unreliability and by this method estimate numerically the factors of safety inherent in the mechanical design.

Much can be done along this line by a clever experimenter, and the method has not yet been fully exploited in many laboratories.

Testing of components is usually possible, too. Whenever tests of components outside the device give valid results, they generally permit much larger sample sizes and consequently better measures of reliability for that part. Such "components" as detonators and vacuum tubes are usually developed as independent "devices."

Many of us have a vague idea that if you build a device out of component parts that have an average reliability of ninety-nine per cent, then the assembled device must have a reliability of about ninety-nine per cent. But a moment's thought will convince you that many of these components must operate (as it were) in series; *i.e.*, the device will not work reliably if any one component fails.

Even a comparatively simple device like the 20-mm. round has a number of identifiable successive processes which must all work as intended in their proper order at their proper times or else failure of the whole operation results.

Functions Itemized

In this case the artillery primer must function on the stimulus given to it; the primer must then ignite the propellant; the propellant must operate satisfactorily over the whole range of temperature and shock environment encountered by the round anywhere it is used and must then send a fuzed projectile forth with a predictable velocity; the fuze in the projectile must not operate prematurely on normal handling or on launching, yet it must respond to its proper stimulus in a thoroughly reliable manner; the fuze must initiate the explosive load of the projectile; and the projectile must function with its proper delays on the proper targets.

Even this simple device, the 20-mm. round, has at least ten distinguishable "components" or "operations," so that the over-all reliability is less than p^{10}, where p is an assumed hypothetical average probability of reliable operation of each component.

For 10 series components (or operations) of 99 per cent reliability each, you will end up with a device of 90 per cent reliability. A device containing 100 such components will be 37 per cent reliable; with 300 such components, only 5 per cent reliable.

Binomial Distribution

Putting it the other way around, the percentage of failure of each component, on the average, must be maintained much lower than for the over-all device. Considering this to be a binomial distribution, it is easily shown that the percentage of failure must decrease roughly linearly with the degree of complication of the device; *i.e.*, with the number of components or processes. The proof follows:

If p is the probability of operation of each component, and q is the probability of failure of each component, assumed the same for all components, then in the case of n-fold complication the probability of reliable operation of every one of the n series components is

$$p^n = (1 - q)^n$$
$$= 1 - nq + \frac{n(n-1)}{2!} q^2 - \frac{n(n-1)(n-2)}{3!} q^3$$

The probability of failure of at least one component, enough to cause failure of the whole device, is thus Q, where

$$Q = 1 - p^n = nq$$

(approximately, when q is small).

This means that the efforts and expense for development, production, and inspection should increase roughly as the square of the number of components, since each component's average reliability must increase n-fold at the same time that the number of components increases by n.

By n we mean the number of identifiable components or processes in the device, which must all either operate reliably or result in failure of the device.

Immediate Result

One immediate result is the observation that when you test components outside the device in which they are to be used, you must establish a reliability average considerably better than the average you expect to get in the device as a whole, over the whole range of temperature, shock, and so on.

Thus if you are satisfied with a 98 per cent reliable fuze, you may have to specify an average reliability of at least 99.98 per cent in all the components and the production processes.

This is one of the strongest arguments for simplicity in design, since so much extra effort must be utilized in developing every component in a complicated device.

Only in this way can the reliability of complex ordnance devices be maintained at a high level while the production rate (which is always highest for simple devices) is maintained high at the same time.

8-speed Atlas miller gets greater spindle accuracy with TIMKEN® bearings

THIS Atlas MFC milling machine has 8 speeds, from 62 to 2870 RPM. It handles the full range of milling, from slabbing and facing cuts to end milling, keyways, finishing and layout work. And no matter what the speed or job, its spindle is held in accurate alignment by Timken® precision bearings. Precision milling is assured.

Due to their tapered construction, Timken bearings carry both radial and thrust loads in any combination. They can be adjusted to any desired preload to prevent chatter and provide maximum rigidity.

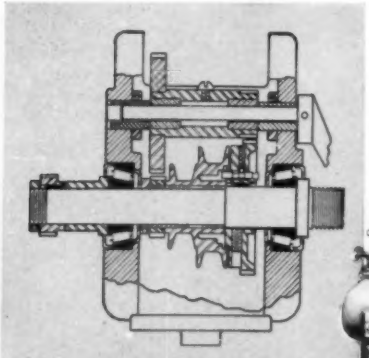
Timken precision bearings are made specifically for precision spindle applications. Timken "Double Zero" bearings are available with a maximum run-out of only 75 millionths of an inch (.000075").

Because of their line contact between rollers and races, Timken bearings provide more than enough capacity for any tool load. And because of their true rolling motion and incredibly smooth surface finish, friction is practically eliminated.

Timken bearings reduce machine tool manufacturing costs too. No special thrust bearings are needed. Assembly and set-up of the bearings are quick and simple.

Get all the advantages only Timken bearings offer you by specifying them for the machine tools you build or buy. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How ATLAS PRESS COMPANY mounts the spindle of its MFC miller on Timken tapered roller bearings for greater spindle accuracy.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

FINISHED TO CLOSER TOLERANCES

Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ⊕ AND THRUST →⊕← LOADS OR ANY COMBINATION →⊕←

Photo by Charles J. Belden, *courtesy of* Field and Stream

Can You Outsmart Canis Latrans?

The Indians called him the medicine wolf, attributing supernatural intelligence to the coyote. *Canis latrans*, as he is known to naturalists, appealed to the first Americans because of his sly wisdom.

But no matter what you call this clever little wolf, he's still a predator who pulls down young calves or the stragglers from a herd of sheep. Respect him for his guile, his ability to survive under the toughest conditions, but shoot him when he makes a pest of himself. Don't try to eliminate the coyote entirely, however, since a large part of his diet is rabbits, ground squirrels, mice and other rodents which need to be kept in check. See your local hunting regulations, too, before shooting the coyote.

Besides controlling predators like the coyote, good sportsmen can help conserve our game resources by being active in local and national conservation programs.

N·R·A RANGER

Write for free booklet on how to start a rifle club . . . win Ranger Shooting Emblems. Sportsmen's Service Bureau, Department **D-5**, Sporting Arms and Ammunition Institute, 343 Lexington Ave., New York 16, New York.

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING... *THROUGH CHEMISTRY*

DU PONT SPORTING POWDERS

WORLD-FAMOUS SINCE 1802